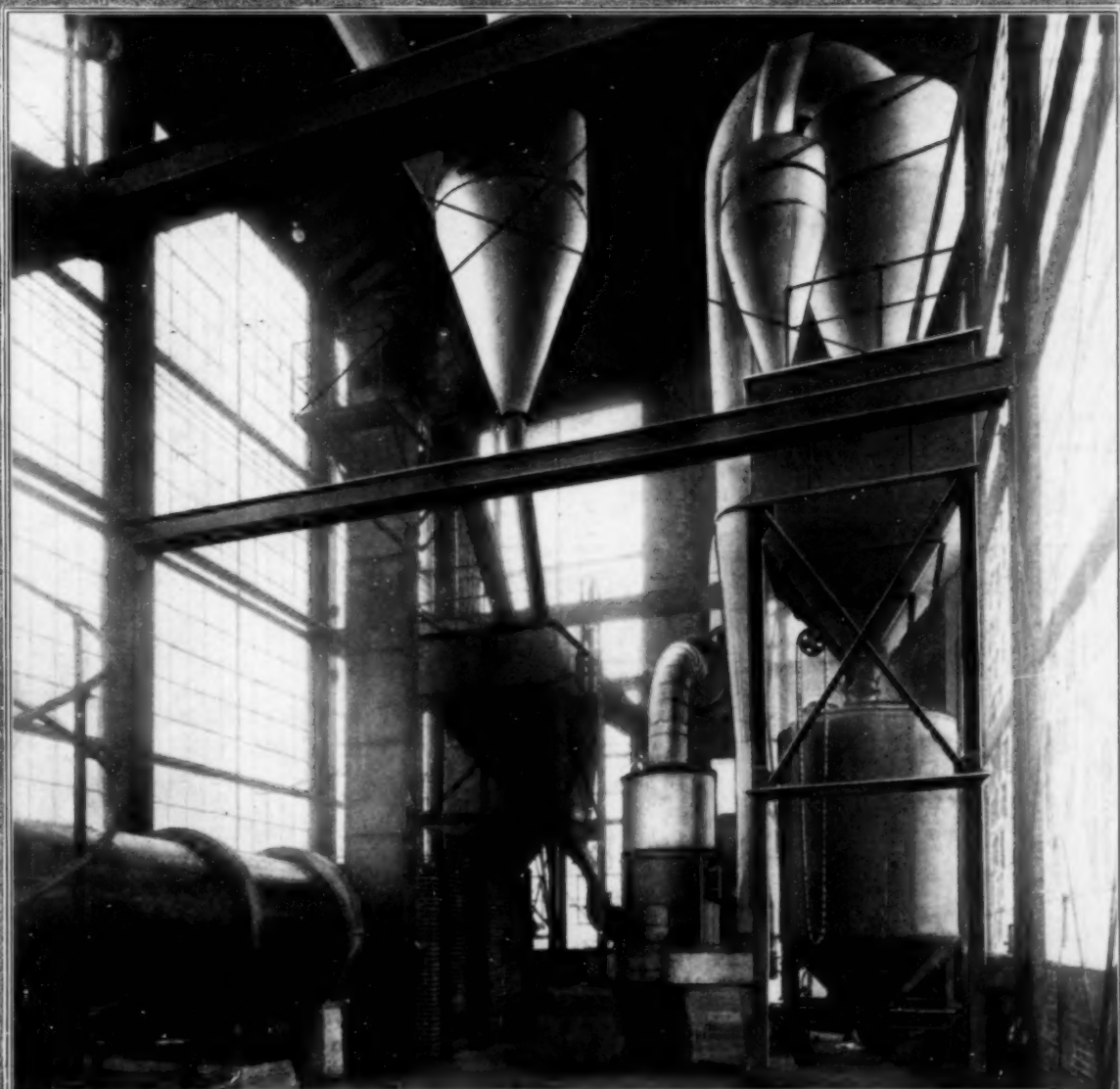


CHEMICAL & METALLURGICAL ENGINEERING

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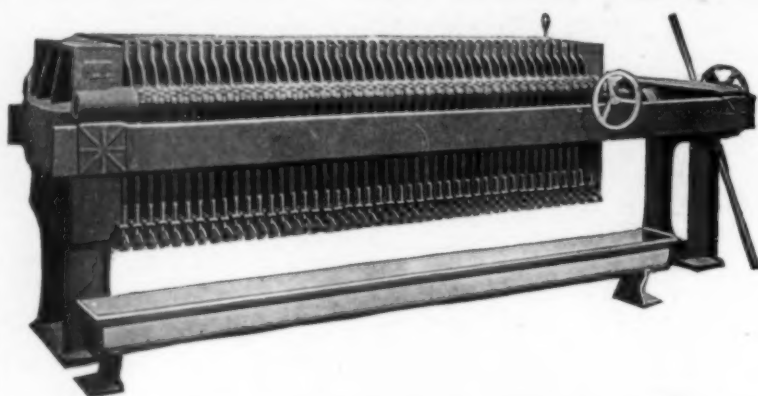
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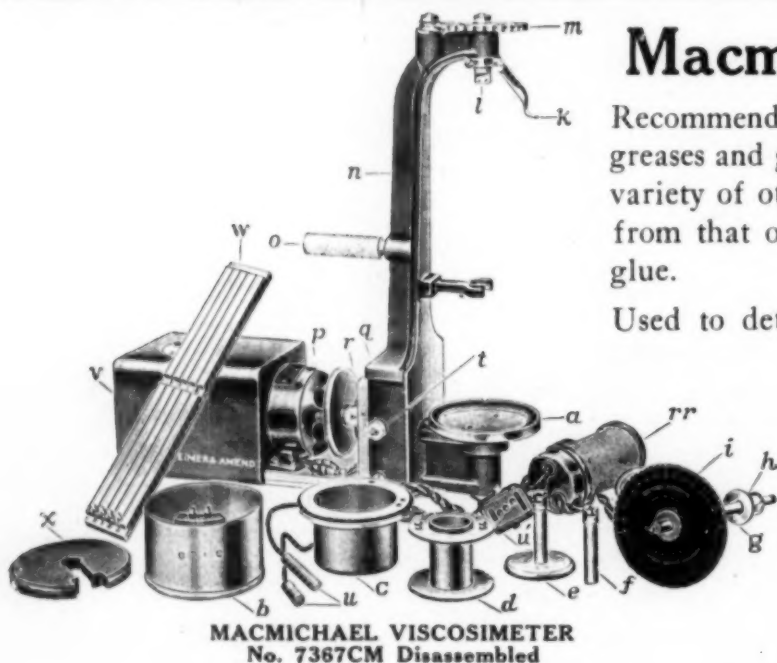
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Number 4

Why Prices Are Up or Down

IT IS useful to make a comparison now and then between what we used to expect would occur and what actually has occurred. Our disposition to repose confidence in current appraisals of what is going to come is increased or decreased according to whether or not observation of the phenomenon shows that there is agreement with the prediction.

A year ago it was a common saying that this time we knew why business was poor; it was because men were waiting for declines in prices and wage rates. When proper adjustments had been made, business would resume at its former gait, only at the right prices and costs.

A survey of the situation does not indicate that this appraisal was correct. Some prices have come down very nearly to pre-war levels, others are below pre-war average prices. Some prices are still very high. According to the theory, the lower priced commodities would be moving freely, men having taken hold again, while the higher priced commodities would be moving slowly because of men refusing to take hold on account of not having got what they wanted. This, however, is not the case. While the general average of commodity prices at wholesale, as reported by the Department of Labor, has averaged about 150 since last May and stood unchanged at 149 for November and December, building materials are about double price, and advanced from 197 in November to 203 in December. Next to "house-furnishing goods," which have been at 218 in the past 2 months, building materials are the highest priced class of commodities in the Bureau of Labor's list of nine groups.

Now it is a fact that there has been a very fair volume of building activity lately. There has not been much factory and bridge construction, but there has been activity in erection of garages, dwelling houses and public buildings. The reasonable assumption is that SMITH is like JONES. JONES hopes that prices and wage rates in general and SMITH'S in particular will come down, but he feels individually that JONES is all right and ought to maintain his position as much as possible. If people will buy from him at high prices, he is justified in accepting the money.

People have been buying building materials fairly well. The builder of a garage or dwelling house wants the new facility before he grows any older. The municipality finds it can borrow money to advantage, by tax-exempt bonds, and goes ahead. These buyers do not wait, and so building materials remain at their inflated price levels.

This explanation does not fit all cases, of course. There are some instances, no doubt, where sellers of a commodity are close together and are able to hold up

prices by refraining from indulging in strenuous competition. In some commodities, like steel and zinc, there is particularly keen competition, and prices are low. Zinc, after having advanced in recent months, is still well below its pre-war average.

The rule that obtains among sellers of commodities obtains also with workmen, only it is applied in a less practical and intelligent manner. The unions have held wages up where they could, even though they have had little employment. Between 60 and 70 per cent of the bituminous coal-mining capacity of the country is under union auspices and the men adhere to their scale, with the result that the great bulk of the coal being produced today is at non-union mines. The unions in the building trade have submitted to slight reductions only, but they manage to get employment while they are not on strike.

Prices and wage rates that are up are up because they could be held up. Prices and wage rates that are down are down because they could not be held up. There has been no general leveling force. It has not been a case of the general value of the dollar increasing. The value of the dollar, as compared with pre-war times, depends on what you wish to spend it for.

The Value of Personnel Boards

ON THE initiative of the always lively and interesting General CHARLES G. DAWES, Director of the Bureau of the Budget at Washington, a Federal Personnel Board has been established under the supervision of the United States Civil Service Commission.

It is indeed high time that such a board should be established. It is to have, among other duties, the "operation of a service through which employees may be assigned to the several departments or establishments in periods of maximum load, thereby permitting appropriations for the several offices to be made on the basis of their normal loads." It is also to include the training of employees for their positions and to adopt, as far as practicable, "the principle of promotion from within in filling the higher positions in the service with a view to offering a career to properly qualified persons who enter the public service."

This is good business and applied psychology. Now we should like to see another Personnel Board organized among bankers and dealers in investment securities and money lenders to select suitable and qualified directors for industrial corporations so that, when the leaders assume the privilege of naming directors to look after their interests, they may select men who have a reasonable sense of what is required of them. Many directors of great corporations are grossly overpaid by their fees of \$10 or \$20 a month or a quarter for their services. Others would be grossly underpaid by fees of a thousand dollars per meeting.

Varieties and Vanities Of Millionaires

AT A DINNER of the Alumni of the Massachusetts Institute of Technology held in Cambridge the other day, one of the speakers who made an address in lighter vein offered a little dissertation on Millionaires: Their Varieties and Their Vanities. We venture to repeat a few of his observations for what they are worth, inasmuch as nearly all of us occasionally seek access to millionaires, and when we meet them we usually want the interview to be of an agreeable nature. We are also likely to be ambitious to induce them to accept our own point of view.

Of course they are of all sorts, but an effort was made to discover some of their common traits. Among these is a general conservatism of disposition and that measure of nervousness about property that follows responsibility. Since the only enduring wealth is that of the mind and all other possessions easily take wings, and millions are not mental, this nervousness is justified.

With responsibility comes the consciousness of it, which frequently engenders vanity. One of its most persistent manifestations has to do with the etiquette of calling. If, let us say, a chemical engineer wishes to bring together millionaires A and B who might become jointly interested in an enterprise, he may count on the response from A that "Mr. B knows where to find me; I shall be glad to meet him whenever he calls," and exactly the same from B in regard to A. Neither will call on the other. But both will lunch together without losing face, and whether one or the other pays for it or the engineer himself pays for it, is unimportant.

Habits of speech are to be observed carefully. If the man of wealth is precise in language it behooves the interviewer to call to service all the grammar he knows, and to avoid any solecism; otherwise he will be classed as an inferior person and cannot possibly get in on the ground floor. On the other hand, if the interviewer's speech is more precise or more elegant than that of the rich man, he is in danger of being classed as a theorist, and 90 per cent of our millionaires hate theorists. This expression of hatred of theorists is rather a fashion of speech than a reasonable conclusion, but its use is well-nigh universal, and it serves as a substitute for thought. Such substitutes for thought are more potent to engender obstinacy than earnest deliberation. It is therefore held to be preferable to refer to every measure proposed in regard to apparatus or materials or plant as "the practical application of science."

By association with bankers the millionaire gets the banking habit of mind. Here we meet subjects that we have frequently discussed editorially. We shall merely repeat as blind spots of the banking mind the belief that a balance sheet tells everything; the lack of appreciation that it is only a record of past performances; and the curious illusion that a man who achieves success in one enterprise is almost certain to succeed in another. What is missed is that the very stratagems which apply successfully in one affair will lead to failure in another. The man who has succeeded, for instance, in the manufacture of silk ribbons has a far more difficult path to succeed in garbage disposal than the one who has worked his way along to the administration of the affairs of either of the two fields of activity.

A passion generally caught from banking associations is to "cut out dead wood." Nine men of wealth out of ten, in approaching a reorganization, do not object to their own lack of specific knowledge of the proposed

undertaking, but at least eight of them will insist on having a hand in "cutting out the dead wood" if they are to participate in the subscription. It is therefore of leading importance to fix upon some part of a proposed undertaking which the underwriters may have the satisfaction of discovering, as dead wood, and cutting out. If they cannot satisfy this passion, they are likely to break off negotiations. They do not seem to care so much what the dead wood is, so long as they can cut. This they feel they must do. If the engineer does not select it, they will; and as likely as not it will be the very heart of the business.

Some day when bankers get a background of chemistry, millionaires will see the need of it, too. Then chemical industry will have smoother sailing.

Chemistry By Mail

LATELY we protested against a French advertisement offering American university degrees for sale. With equal fervor we object to a misleading announcement in a number of popular American magazines offering to prepare subscribers to earn big money in chemistry by means of correspondence. This consists of thirty-one lessons and lasts 8 months, with the intimation that the subscriber will be a chemist at the end of that time. Salaries of \$10,000 to \$15,000 a year are set forth as available, to all appearances, to those who take the course. "If your present earnings do not suit you," says the precious booklet which is sent to inquirers, "if you cannot seem to get ahead or do not earn enough to enjoy life, take up chemistry and fit yourself in a few short months to enter a profession which offers unlimited opportunities for sure and rapid advancement."

There's little use in giving more details. They charge \$125 for the course, with special discounts for those who make haste to subscribe. The method is a "direct short-cut with all frills and useless details eliminated." No physics, no physical chemistry, no mathematics beyond simple arithmetic—less indeed than may be found in any \$2 textbook; and all for \$125, which includes the "outfit"—"six test tubes, one glass stirring rod, two glass funnels" and some other things.

The advertisement emanates from a "Chemical Institute of New York, 140 Liberty St. T. O'CONOR SLOANE, A.B., A.M., Ph.D., LL.D., Educational Director." The picture of Dr. SLOANE is given, which shows him to resemble G. B. SHAW, and it is stated that he was formerly treasurer of the American Chemical Society. A quotation from "Who's Who in America" relates that he made his Ph.D. at Columbia University in 1876 and that he taught natural science at Seton Hall, which is a reputable Catholic school for boys at South Orange, N. J. Inquiry brings out the fact that about 25 years ago Dr. SLOANE was treasurer of the American Chemical Society for a short time. He has written some elementary books on electricity, and we are informed that they are not without merit. We know nothing against his earlier career. What appears probable is that in his later years he has got into bad company. Surely no reputable chemist would lend his name to this sort of thing.

We want to do everything we can to advance the teaching of chemistry, so that the public may understand what the science means. But in our judgment this advertisement is misleading. It seeks to get money out of young men under false pretenses, which is a mean trick that should be stopped.

Psychological

Adventures in Stupidity

PROFESSOR LEWIS M. TERMAN contributes to the January number of *The Scientific Monthly* an essay entitled "Adventures in Stupidity," which relates to an inferior student called "K." How K managed to slip through high school and graduate at the age of twenty is not given, although the eminence and wealth of his father may have had something to do with it.

He was well brought up, handsome, rather engaging in manner and generally prepossessing in appearance. But after a couple of weeks' experience one of the instructors asked Professor TERMAN to look him over, saying he had never met anyone so stupid. He proved to have a mental age of ten to twelve years, despite the fact that he could read, write and spell acceptably, could drive his high-power motor car as well as the average person, was diligent in his work, and had abundant mental equipment to be, for instance, a champion athlete. At the end of the first term he failed in all his studies and was glad to go home and be a clerk in his father's store. He had not wanted to go to college anyway.

The tests as recorded are involved in psychological jargon that is unfamiliar to most of us, but we can give a few notes that illustrate his intellectual stature. Asked to read a newspaper article and report on it, his replies were childish and inaccurate. He could sometimes carry out instructions if given in a fifteen-word sentence, but if the sentence was thirty or forty words long he would respond with a blank stare. He could not take a mixed sentence, such as "people are many candy of fond," and arrange the words to mean something, because he cannot profit from logical cues. He thinks New York is the largest city in the country "because it covers such a large area." Even his grasp of familiar words is hazy. For instance, lecture means "to be taught," ramble "to go fast," conscientious "very good in his work," brunette "white" and tolerate "to get away from." Summing up, he "lacks intellectual initiative, planning range and flexibility of association, analysis of a situation into its elements, alertness and the direction of attention toward the significant aspects of experience. He is unable to master the intellectual shorthand of general ideas."

Well, how many of us can do these things? It is said with no little authority that the great majority of our high school graduates are drawn from the best 25 per cent of our population, and that the typical university graduate ranks in intellectual endowment well within the topmost 10 per cent. "K is stupid only by contrast. Only occasionally does an individual of his moderate ability manage to graduate from high school or enter college. . . . K is only moderately less dull [sic] than the average of the genus homo, judging from intelligence scores made by nearly 2,000,000 soldiers. His intelligence is probably not equaled or exceeded by more than 70 per cent of our white voters by more than 50 or 60 per cent of semi-skilled laborers. It is probably not equaled or exceeded by more than 30 to 40 per cent of our South Italian or 20 to 30 per cent of our Mexican immigrants. Compared with the average American negro K is intellectually gifted, being equaled by probably not more than 10 to 15 per cent of that race."

Professor TERMAN'S conclusions are also interesting. He says K is now a clerk in a general store, and apparently making good. There is no reason why he

would not make a reasonably good baker, barber, bricklayer, butcher, carpenter, drill-sharpener, freight checker, game warden, glass blower, harness maker, horse clipper, jail keeper, lathe hand, policeman, professional ball-player, plumber, prize fighter, pedler, railway brakeman, riveter, roofer, section boss, soldier, street-car conductor, timer, truckman, valet, weaver or yardman, or one of a large variety of clerks. He can be loyal to a political party, but he cannot grasp political principles. He can repeat a political slogan, but he cannot understand it.

In short, K represents upward of 50 per cent of the people in his lack of what we call, generically, sense. If we entrust him with work that calls for thinking and judgment, he will fail. If he fails, it may cost us, to put it bluntly, all kinds of good money. He is one of possibly 50,000,000 persons in America who "lack the intellectual shorthand of general ideas"; who can't sense things so as to know what's what.

There's no use getting angry at such folks; the incidence of our wrath should be on ourselves when we entrust them with responsibilities which they are not equipped to meet. It also explains why things happen in Russia as they did when a "dictatorship of the proletariat" was established. K represents the preponderant majority of the proletariat.

Real Progress in

Industrial Standardization

DURING December there was held at the Bureau of Standards a conference on sizes and specifications for dry cells, at which a large number of industrial representatives co-operated with the bureau in formulating a revision of the specifications which are recommended by that institution.

One of the most far-reaching influences which will come from the conference was the adoption of recommendations regarding a limited number of standard sizes of batteries and dry cells. Thus all but two of the larger sizes and all but five of the flashlight sizes were dropped from the lists that will hereafter be known as "standard" sizes of dry cells. It was found that this limited number of sizes represented substantially all of the important commercial business of the country. Of course this limited number of cells permits combination into a wider variety of batteries, and for this purpose three flat, three tubular and one box type batteries were recognized for flashlight purposes and two types of radio battery assemblies were also recognized as combinations of the smaller cells. Similarly several combinations of the larger cells were recognized as standard battery assemblies. But all in all the number of stock types which must be kept under these recommendations is very greatly reduced from the old practice.

Industry can well welcome this sort of progress. It is the truest form of assistance and co-operation on the part of the government and one for which the industries may ask greater attention in the future. Nothing has contributed so much to American success as the ability to accomplish mass production, with a minimum of profit on each of a large number of units. This can be done only if the variety of units is made a minimum.

Other industries may well "take their cue" from the battery business and see if they too may not accomplish as much in this way as is promised by these recommendations recently adopted in that field.

Readers' Views and Comments

College Degrees for the Credulous

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Dec. 7, there appeared an editorial, "College Degrees for the Credulous," based on an advertisement from the columns of *Chimie et Industrie*, published by the Société de Chimie Industrielle at Paris. This advertisement promised French chemists doctor's degrees from an American university, "officially recognized," by the simple process of correspondence and presumably for a suitable fee. As president of the American Section of the Société I could not fail to take notice of your editorial, and promptly brought the matter to the attention of its secretary, M. Jean Gerard, from whom I have just received a reply, the translation of which I herewith inclose. I am asking you in fairness to our French colleagues to have the goodness to publish M. Gerard's letter, as I think it will not only be greatly appreciated by them as a courtesy on your part, but I think it will be of more than passing interest to your readers.

I am sure that French chemists in general will be glad that this matter has received so much attention. The editorial which will appear in the January number of *Chimie et Industrie* on this matter will place them on their guard against advertisements of that nature and I know that American chemists will be thankful to you and to *Chimie et Industrie* for protecting the fair name of their universities against unscrupulous degree factories.

Columbia University,
New York City.

J. E. ZANETTI.

Jan. 3, 1922.

MY DEAR PRESIDENT: Your letter of Dec. 1 reached me safely and has received my most careful attention.

The small advertisement of which you speak was accepted by an advertising agent knowing little of scientific questions, and he accepted it without thinking that its insertion would cause annoyance to our American friends.

I beg you to believe that I sincerely regret the insertion of that advertisement.

You know what admiration our journal *Chimie et Industrie* entertains toward American universities. In no case would we be willing to hurt in any way the excellent reputation which they enjoy in our country, and we try on the contrary at every chance that we have to increase that good reputation.

The relations that we have with American chemists individually and collectively are the best proof of our desire to continue and to increase between our nations an intellectual collaboration, which would contribute in the greatest possible way to scientific progress.

It is in this spirit that I believe it my duty to bring to your attention that besides the campaign by advertisements, numerous French chemists have been approached with circulars, of which the following is typical:

SIR: I beg to call your attention to the advantages that would accrue to you in the exercise of your profession from the acquisition of the degree of Doctor in Chemistry from a university officially recognized in the United States.

As General Delegate of the Orientale University of Washington, D. C., I gladly place myself at your disposal for all information and requirements in this matter.

The diploma may be obtained by the method of correspondence in about three months.

(Signed) COLLEREDO.

Villa Bella Vista,
Roquebrune, A. M.

As in our country we are not very well informed about the mechanism of American universities, it would be desir-

able that this question should be elucidated by you personally in an article that you would prepare and which we would most gladly publish in the economic section of our journal. This question will in addition be treated in an editorial in our next number over the signature of M. Charles Lormand.

I beg to express my sincerest wishes for the excellent relations between American and French chemists.

(Signed) JEAN GERARD.

Sulphuric Acid Air Lift

To the Editor of Chemical & Metallurgical Engineering

SIR:—I notice in the third of the series of interesting articles on "Recent Developments in the Sulphuric Acid Industry," by A. M. Fairlie, published in your issue of Nov. 23, 1921, that a description is given of a so-called Bihn-Jones automatic air device for elevating sulphuric acid which it is stated was first marketed in 1915. As a matter of fact the device described appears to be identical with that introduced 22 years ago by William Barnes, at one time foreman plumber of the Muspratt Works, Widnes, England, and which has been used universally in the works of the United Alkali Co. as well as by other acid makers for the last 20 years. The device is an admirable one and has the advantage of being adaptable to the acid eggs already existing in practically all sulphuric acid works. Apart from the wear and tear when used on very small eggs and from occasional trouble through particles of grit interfering with the action of the float or the back pressure valve it gives no trouble at all. The automatic elevator was never patented by the United Alkali Co., by whom Albert Jones was at one time employed.

My only reason for writing is to point out that the device is scarcely a novelty or recent development, and to insure the credit for its invention being given in the proper quarter—namely, to William Barnes.

Widnes, England.

C. S. IMISON.

The Manufacture of Naval Stores From the Dead Wood of Southern Pines

To the Editor of Chemical & Metallurgical Engineering

SIR:—C. M. Sherwood in his article on "The Manufacture of Naval Stores From the Dead Wood of Southern Pines" makes the statement that the composition of pine oil is rather uncertain and mentions only one probable constituent, terpineol. In Schimmel & Co.'s semi-annual reports, April, 1910, eleven different constituents of pine oil were reported. Six of these, however, were really turpentine constituents, since they had boiling points below 177 deg. C. No quantitative data were given, but apparently the most important constituents were identified. This work was not only abstracted in *Chemical Abstracts* but was also mentioned in detail in Forest Service Bulletin 105, on "Wood Turpentines." This bulletin might also have given Mr. Sherwood more information on the comparative composition of wood and gum turpentine than he seemed to have at his disposal.

We will agree that the origin of pine oil is still a mystery, but from the information given in Bulletin 105 it seems very doubtful that it "is present in the living tree as an essential oil and is not a product of

hydrolysis or oxidation." Since the oleoresin produced in a longleaf pine tree does not contain pine oil, as is shown from the composition of gum turpentine, it is difficult to see how pine oil can be anything else except an alteration product of the original oleoresin. That the final resin contained in the stumpwood is a product of gradual change from the original fresh oleoresin is indicated by the fact that the crude wood turpentine from the steam distillation of green sawmill waste contains very much less pine oil than that from stumpwood, and also from the fact that the turpentine from this sawmill waste is more like the gum turpentine in that it contains so small an amount of dipentene that it cannot be readily recognized.

Very few writers on the subject seem to know that the first extraction plant to use the Yaryan process was built at Cadillac, Mich. This was not an experimental plant, but was of full commercial size and operated successfully for some time. The quality of the wood available, Norway pine stumps, was, however, so poor that with the declining prices for turpentine and rosin it was necessary to suspend operations.

L. F. HAWLEY,

In charge Section of Derived Products.

Forest Products Laboratory,
Madison, Wis.

To the Editor of Chemical & Metallurgical Engineering

SIR:—One cannot dispute the statement by Mr. Hawley that commercial pine oil contains several distinct compounds. We endeavored to make this clear in the article on naval stores, but did not care to mention the constituents other than terpineol, because Teeple and Toch have shown quite conclusively that this compound forms by far the greatest percentage of the high-grade commercial oils, the quantity of other constituents depending largely on the degree of fractionation.

While there is no doubt that oleoresin contains no pine oil, it is acknowledged that wood from the same tree, upon being steam distilled, will show considerable pine oil. It was our theory, therefore, that pine oil is not a product of oxidation or hydrolysis, but rather an essential oil of the trees. Neither theory has been proved or disproved, and therefore we are inclined to consider the origin of pine oil an unsolved problem.

We have had the pleasure of reading Forest Service Bulletin 105, written by Mr. Hawley, and believe that some very valuable facts for wood turpentine producers have been brought out. As he points out, the product varies so much in different methods of manufacture that it is difficult to make any certain statements regarding the composition. Even with the same general process, the turpentine may be of an entirely different character under varying conditions of operation. It is for this reason that it is essential to insist upon uniform methods of operation in plant practice. We have noticed in our experiments that under certain conditions a refined turpentine will be obtained which has a gravity of 0.860 at 15.5 deg. C., while another one with almost an identical boiling range, refractive index and polymerization residue has a gravity of 0.864 when the operation is conducted slightly differently. In the latter case there is probably only a very small percentage of dipentene, while in the former the percentage of dipentene is probably quite large. In short, the character of wood turpentine varies so greatly under different conditions of operation and refinement that we did not feel justified in discussing it in more detail than given in the article.

C. M. SHERWOOD.

Brunswick, Ga.

The Six Blind Men and the Jellyphant

To the Editor of Chemical & Metallurgical Engineering

SIR:—Our good friend Jerome Alexander has been seriously ill, but now I am glad to say he is back at work again, busier than ever with colloidal aggregates and their dispersions. While he was mending, feeling the Muse of Poetry hovering nigh, he bade the ghost of John Godfrey Saxe approach and after duly polite acknowledgment to him for his lead in form, he hearkened to the Muse and wrote. Then, having finished the work, he conjured up the shade of Samuel Taylor Coleridge for aid in developing a marginal syllabus which was duly added to the poem. It occurs to me that you should publish it to tell the world how many sided colloid chemistry is.

MARTIN SEYT.

The Six Blind Men and the Jellyphant

BY JEROME ALEXANDER

There were six men of chemistry
To research much inclined
Who went to see the Jellyphant
(Though all of them were blind),
That each one by observing well
Might satisfy his mind.

The old professor
rendereth an opinion.

The first approached the Jellyphant
And, happening to note
Its thirst for sour and basic things,
At once began to gloat.
"I see," quoth he, "the Jellyphant's
An ampholytic goat!"

Hofmeister observeth
the ampholytic
function.

The second, happening to touch
Th' amino acid paws,
Exclaimed, "This is a biped which
Obeys all biped laws!
To call it quadruped shows lack
Of reason or of cause."

The younger Ostwald
declareth the
Jellyphant to be a
beast of froth and
foam.

The third said, "Every housewife knows
Why mayonnaise stands up.
Well-made emulsions don't fall out
When you invert the cup.
'Tis plain the Jellyphant is an
Emulsoid-colloid pup!"

W. B. Hardy de-
clareth the Jelly-
phant to be a bony
beast.

"I feel a firmness," said the fourth,
"That seems to indicate
A solid backbone in the beast.
I have it! Sure as fate,
The Jellyphant is really a
Suspensoid vertebrate!"

T. B. Robertson and
Mistress Lloyd
would have the Jelly-
phant to shift its
innards.

The fifth deaminized its arms,
But still it quenched its thirst,
Whereat they cried, "This hootch-
hound is

Of all we've seen the worst!
It's a keto-enol chameleon.
Deny this fact who durst!"

Jacques Loeb
shooeth back the
prodigal Jellyphant
into the chemical
fold.

The sixth immersed the Jellyphant
In water—without malt,
And heard it sing H-ion hymns
In tune, without a fault.

"Now, of a truth," he cried, "this beast's
An orthodox old salt!"

And so these men of chemistry
Disputed loud and long.
Each in his own opinion was
Exceeding stiff and strong.
And each was partly in the right,
Though all of them were wrong.

So, oft in scientific wars
The disputants, I ween,
Neglect, the while they make their
notes,
What all the others mean,
And so describe a Jellyphant
Which none of them has seen.

German Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

ESSEN, Dec. 22, 1921.

THE chemical industry in general is suffering severely from a scarcity of fuel and although the larger works have made themselves partly independent from coal by acquiring extensive lignite deposits, their supply is inadequate since the railways are also hampered severely by lack of fuel. The acuteness of the situation is further accentuated by the low water in the inland waterways, which prevents boats from carrying full cargoes, thus increasing freight rates.

SUGAR

The prospects for the 1921-22 season in the sugar industries are considered a distinct improvement compared with the last outputs. The harvested acreage of sugar beets has increased by a little over 22 per cent and will be equal to an increase of 13½ per cent in the sugar production. Though the production reached its lowest level in the harvest of 1919-20 and has been recovering gradually ever since, the figures are still far from the pre-war production. It must be remembered, however, that Germany has lost a vast amount of sugar beet acreage on account of the peace treaty. While in 1919-20 the sugar output dropped to ⅓ of the pre-war figure, it is fully expected that the output of the present season will be equal to ⅔ of the 1913-14 figure. The production will in all probability just cover the inland requirements and obviate any importations of cane sugar from abroad. Of course, nothing will be left over for export and by government order sugar is excluded from import as well as from export. While immediately before the war, Germany's share in the sugar production of the world amounted to 11.9 per cent or 25.2 per cent in proportion to the beet sugar industry, these figures dropped to 4.6 and 21.5 per cent respectively, while for the present season these figures stand at 8.1 and 26.2 per cent.

NITROGEN FERTILIZERS

The fact that the combined German nitrate producers had entered into an agreement with the English and American producers not to underbid the current prices of the world markets has alarmed the consumers so much that they brought the matter to discussion in Parliament. The farmers naturally got nervous in the expectation that such a stand on the part of the producers might also reflect upon the inland prices, and an assurance was given to control inland prices to a certain extent as well as to regulate the quantities eventually admitted for export. Several cargoes of nitrate have been imported from Chile at a time before the mark dropped out of proportion of its value altogether, but even by allowing for these conditions it is quite out of the question for the farmers to buy the stuff. It is not used as a fertilizer but is worked up as a raw product for the manufacture of concentrated nitric acid. The demand for fertilizers has at the same time slackened considerably and the German ammonia syndicate formed an affiliated company under the name of Nitrogen Credit Co., Ltd., with a capital of 500 million marks which will enable the farmers to buy nitrate fertilizers on long terms of payment, will help to bridge temporary financial difficulties and will also help to increase the consumption of nitrate fertilizers.

The Oppau plant is recovering gradually from the recent disaster and part of it will be restarted within

the next few weeks for the manufacture of nitrates. The Oppau disaster, in which the plant was insured only in small proportion to its actual value, has drawn the attention of the workmen's organizations to the fact that large companies, particularly in the chemical industry, are gradually breaking away from the practice of insuring their plants and instead accumulate certain reserves under the heading "self-insurance." While in the Oppau case this self-insurance could easily be borne by a company as strong financially as the huge chemical combine (although even in this instance the accident is cited as a reason for a further increase in capitalization), the workmen are beginning to fear that in the event of a similar disaster occurring in the plant of a company less sound financially this self-insurance might prove insufficient to rebuild the plant so that the company would be compelled to dismiss its men suddenly. The matter of compulsory state insurance has been brought up in Parliament.

SULPHUR

While the German chemical industry as a whole is practically independent of import of raw materials, the sulphuric acid industry is in this respect a great exception, being almost entirely dependent upon the import of pyrites. The available raw material in Germany consists of zinc ores, the quantities of which are, however, quite insufficient to meet the demand of the chemical industry. Sulphur ores are imported mainly from Spain and from Scandinavia. Owing to the unfavorable rate of exchange the import of these ores has not reached half the pre-war figure, but preference is given to Scandinavian ores over the Spanish ones, contrary to pre-war practice. The consequent high prices of sulphuric acid and the inadequate quantities available have given fresh impetus to the utilization of sulphur contained so abundantly in the coal and in blast-furnace slag either to manufacture sulphuric acid or to combine the sulphur directly in another form. None of the processes so far suggested has reached a commercial stage as yet.

PHOSPHATES

Phosphates manufactured from the natural calcium phosphate also demand a very high price due to the fact that the raw material mentioned must be imported from the United States or from North Africa. The dependence of Germany from these sources is felt the more as other phosphate fertilizers such as the basic slag, a byproduct in steel works, must now be imported to a greater extent owing to the loss of so many steel works in Lorraine, Luxemburg, Upper Silesia and the Saar district in consequence of the peace treaty.

TAR PRODUCTS

The market for tar products is very firm of late, due probably to the fact that an agreement with France has been reached regarding the compulsory supplies of tar and tar products as outlined in the Versailles treaty, so that deliveries have been commenced. Like every other branch of industry the tar industry is severely hampered by a scarcity of railway cars because the railways cannot get sufficient coal. This scarcity has been temporarily so great that the railway authorities were even compelled to resort to war measures in requisitioning coal on the lines to be able to keep moving, much to the detriment of the works to which such coal was consigned.

Recent Progress in Electrical Precipitation

Brief Description of the Electrical Field Existing in a Cottrell Precipitator—Reduction in Efficiency Found to Be Due to Back Ionization on a Non-Conducting Plate—Development of a Relation Between Electrode Size and Precipitation Rate

By EVALD ANDERSON

THE commercial development of electrical precipitation during the 12 or more years that have elapsed since Dr. Cottrell conceived and built the first successful commercial precipitator has been in the hands of two rather distinct classes of workers. The engineers, on the one hand, have designed and built precipitators (or treaters, as they are called) and have changed and improved these from time to time so that the modern installation is a very different structure from the earlier ones. The physicists and laboratory investigators, on the other hand, have been more concerned with the fundamental principles involved in the phenomena of precipitation, such as the characteristics of the electrical field in a precipitator and the factors which govern the actual rate of precipitation.

Of these two groups, the engineers have made much the better progress. In fact, it can probably be said without injustice that with but few exceptions all the development in the art that has taken place has until recently been due solely to the engineers. This discussion, however, will be more concerned with the physicists' and investigators' side, and the report of the engineering development that has been done in these years will be reserved for a separate paper.

TYPES OF TREATERS IN USE

Considering the length of time that has been available for investigation, and particularly the many opportunities for research of a fundamental nature, the progress that has been made has not been very rapid. Take, for example, the type of precipitators that are now used. These types are, of course, based primarily on the fundamental principles involved, and any great advance in this field of knowledge would necessarily be reflected in the apparatus erected for the commercial embodiment of the process. The only types in commercial use today are the so-called plate, pipe and transverse screen treaters, the name in each case being derived from the kind of collecting electrode used. Of these three, the first two were used in the very beginning of the commercial development and the last was described by Dr. Cottrell in his early patent specifications.

Nor have there been until recently many advances in the theory of the process. Most physicists who have investigated the problem have based their theories on the well-known laws of the conduction of electricity through gases, and have assumed that the forces acting in an electrical precipitator are not much different from those that would come into play if an externally charged particle were placed in an electric field. Aside from some improved methods of determining the mobility of such charged particles and some refinements in calculating the strength of the electric field, the latter attempts to explain the process differ little from the earlier ones.

Perhaps the chief reason for this lack of progress has been the difficulty of doing quantitative experimental work on a laboratory scale. For example, practically all such work necessitates a source of fume- or dust-laden gases of controllable characteristics, and this in itself is a difficult problem. Furthermore, the characteristics of the electrical field are very often entirely dissimilar in a small laboratory precipitator from those obtaining in a large installation, even when care is taken to maintain comparable conditions. As a consequence, it has seldom been possible to duplicate field conditions in laboratory investigations or to duplicate laboratory results in actual field operation. Moreover, the ordinary electrical precipitator is not amenable to modifications for experimental purposes, so that field experimentation has been difficult.

ESSENTIALS OF ELECTRICAL PRECIPITATION

Considered superficially, electrical precipitation of suspended particles from gases is very simple. The ordinary precipitator is merely an arrangement of two electrodes of the point to plate type, with a unidirectional potential difference established between them, of sufficient magnitude to cause ionization of the gas at the point, or discharge electrode. The ions thus formed are forced over to the plate or collecting electrode by the electric field, and if any solid particles are present in the gas and pick up any ions, they will also be forced over to the collecting electrode. However, while any such arrangement, or in fact any arrangement whatever consisting of two opposing electrodes in the gas, will precipitate a certain proportion of the suspended particles, the rate of precipitation in many cases is too slow for practical consideration.

A full knowledge of the law governing this rate of precipitation is, of course, absolutely essential for satisfactory progress in the art, and most of the investigations that have been carried on in this field have been concerned with factors pertaining thereto.

BACK IONIZATION

As has already been indicated, there have been many discrepancies between the results of most of the investigations and actual practice. One of the most important causes of these discrepancies has been the phenomenon which has been called "back ionization." It was discovered early in the application of the process that often with certain types of fume quite irregular and unsatisfactory operation resulted from no apparent causes, the usual manifestation being a considerable loss in efficiency and increase in power consumption. It was also discovered that the operation could often be greatly improved by the addition of water vapor to the gases. The real nature of the disturbance was unknown, however, until E. R. Wolcott of this laboratory conducted

an extended investigation in this field. He showed (*Phys. Rev.*, N. S., vol. 12, 1918) that the cause of the disturbance in most cases lay in the non-conducting nature of the deposit. Thus when a non-conducting material is placed on the plate in a point to plate electric field, ionization takes place at the plate near the edges of the dielectric, while otherwise the ions are formed only at the point. Ions of the opposite sign to that of the point are thus introduced into the space between the electrodes, and these not only lower the maximum voltage of operation but also undoubtedly neutralize the effect of some of the ions of the opposite sign which would otherwise take active part in the precipitation.

NON-CONDUCTING SURFACES ON ELECTRODES

One can readily see how this effect is brought about. It is well known that ionization can take place only where the potential gradient exceeds a certain fixed value for each particular gas, and that with electrodes of varying curvature this gradient will be greatest at places of maximum curvature, as at the point in a point to plate arrangement. If now the plate be covered except in isolated spots by another dielectric as, for example, by an insulating powder, or by a sheet of mica having a few holes, the plate itself becomes equivalent to points at such places where it is not covered, the only difference being that at the point the dielectric is entirely air, while at the plate the dielectric is primarily some solid material. The potential gradient can, therefore, become sufficiently high, even at the plate, to cause ionization, and the electrode arrangement then becomes one of a system of points, instead of point to plate. Consequently, while there still may be a unidirectional current flowing, the ions will no longer be substantially of one kind traveling in one direction, but will be of two kinds traveling in opposite directions, so that ions coming from the point may be partly or wholly neutralized by those coming from the plate.

Then, too, the maximum voltage which can be maintained at ordinary pressures and distances is much lower when the point is positive than when it is negative, so that anything which tends to modify the plate, when it is positive, into a point or multiplicity of points greatly lowers this maximum voltage.

FUNCTION OF WATER VAPOR

The obvious remedy for this condition when brought about by a deposit of fume on the plate electrode is, of course, to make this deposit conducting. This can be done in many ways, but the easiest way is to introduce moisture. It then becomes a question whether or not the material precipitated absorbs or adsorbs water vapor at the working temperatures so as to become conducting. In this respect there are great variations as, for example, from hygroscopic materials which *absorb* water readily, to substances like glass which *adsorb* moisture and become conducting when in the presence of water vapor of sufficient concentration, or substances like sulphur or silica which remain non-conducting even in the presence of fairly high concentrations of water vapor.

In most cases of actual practice, the desired conductivity of the deposits can be reached either by maintaining the temperature at the collecting electrodes so low that the relative humidity near the deposit becomes sufficiently high due to the water vapor naturally occurring in the gases, or by adding water in the form of spray or steam directly to the gases. In other cases the

collecting electrode itself is covered with a film of water, which is then used as a carrier for the precipitated material.

ELECTRODE SIZE VS. RATE OF PRECIPITATION

With this disturbing element understood and capable of being controlled, it has been possible to make better progress in the determination of the factors governing the rate of precipitation. Engineers of this company are just completing a lengthy investigation in this field. This investigation has to do largely with the relation between the size of the electrodes and the precipitation rate. The fume in this case was a soluble potash salt, carried by gases that were saturated with water vapor, so that the actual particles which were precipitated were particles of solution. Consequently the deposit was not only conducting but the electrodes were also self-cleaning, since the collected solution flowed off as soon as it was precipitated.

As a result of these experiments it is now possible to calculate and predict the gas volume, capacities and precipitation efficiencies of treaters or precipitators with much greater accuracy and certainty than has hitherto been possible. Furthermore, the design of such a precipitator can now be made on a sounder economical basis. For example, where the chief reason for installing precipitators is to save the values carried by the gases, it obviously makes a big difference in the design of the treater whether the material in the gases is, say, cement dust, worth perhaps \$1 per ton, or lead fumes the value of which may be \$50 per ton or more. In the former case it would naturally not pay to construct a very expensive precipitator with high efficiency, while in the latter case such a precipitator could economically be built. In both cases the aim should necessarily be to build such a treater that the net profit on the collected material, after deducting interest on the first cost, depreciation and operating expenses, will be a maximum.

RATIONAL DESIGN OF TREATERS

W. A. Schmidt of this company has developed a formula, based on the results of the investigation above referred to, by the use of which it is now possible to design and build precipitation installations on this really economical and logical engineering basis. This equation is of the form

$$x = a \left(\frac{\log \frac{b}{c \log d}}{\log d} \right)$$

In this equation a is the gas volume to be treated, b is a function of the unit cost of the precipitator, the rate of interest and depreciation and the cost of labor and power. The value of the solids carried by the gases is represented by c , d is a function of the specific precipitation rate for the fume or dust considered and x is the optimum size of the precipitator.

In this expression everything except x can be determined. Thus the gas volume to be handled, together with the amount and nature of the suspended solids, is always determined before any estimates are made. The potential value of all of the suspended matter can then be computed. The cost of labor and power, as well as the unit cost of construction, is ordinarily known from previous installations, and the constant d is either known from similar installations or preliminary tests can be made for its determination.

The development of such an equation represents a

distinct advance over the former methods of design where the estimates could only roughly be based on some former installations with whatever reservations the designer's ordinary judgment considered necessary. Of course, there is still much to be learned. The factors which influence the power consumption are not well known, nor has any satisfactory quantitative relation been determined between the rate of precipitation and the treater potential. Then there is the quantitative effect of the physical nature of each particular fume. In many of these cases sufficient data have been accumulated to express the relations graphically, but until a satisfactory analytical expression can be derived the problem cannot be considered as solved.

The accompanying table indicates the nature of the agreement between calculated and observed values for the precipitation efficiency, as based on the result of the recent investigations.

Type of Treater	Character of Fume	Gas Volume, Cu.Ft. per Min.	Efficiency	
			Observed, Per Cent	Calculated, Per Cent
Pipe.....	Potash fume.....	23,000	86	86
Plate.....	Potash fume.....	18,000	75	71
Pipe.....	Cement dust.....	150,000	94	92
Pipe.....	Metallic chloride.....	15,000	97	98.8
Pipe.....	Lead fume.....	102,000	82	85
Pipe.....	Bismuth fume.....	5,000	90	92
Transverse screen.....	Potash fume.....	1,000	73	75

Considering the wide variation in both the character of fume and the gas volumes handled, the agreement is encouraging and justifies the expectation of still further advances in the many other directions still under investigation.

Laboratories Western Precipitation Co.,
Los Angeles, Cal.

Copper, Lead and Zinc Production in the U. S. for 1921

THE smelter production of copper in 1921 from ore mined in the United States, as shown by the actual production for the first 11 months and by estimates made by smelting companies for December, was about 461,000,000 lb., according to a report by H. A. C. Jenison of the U. S. Geological Survey. The refinery production as similarly shown was about 601,000,000 lb. from domestic material and about 320,000,000 lb. from foreign material.

According to the records of the Department of Commerce the total imports of copper for the first 11 months of the year in ore, concentrates, matte, blister and refined copper were about 318,000,000 lb., of which about 68,000,000 lb. was refined copper and 157,000,000 lb. was blister copper. The exports for the first 11 months totaled about 567,000,000 lb., of which about 538,000,000 lb. was new refined copper and 29,000,000 lb. was manufactured—wire, rods, pipes, tubes, sheets, etc.

The quantity of primary refined copper withdrawn on domestic account during the year was about 572,000,000 lb., calculated as follows:

	1920	1921
Refinery production from domestic sources.....	1,182,000,000	601,000,000
Refinery production from foreign sources.....	344,000,000	320,000,000
Imports of refined copper.....	109,000,000	75,000,000
Stocks of new refined copper Jan. 1.....	631,000,000	659,000,000
Total available supply.....	2,266,000,000	1,655,000,000
Exports (exclusive of manufactured copper).....	553,000,000	587,000,000
Stocks on hand Dec. 31.....	659,000,000	496,000,000
Total withdrawn on domestic account.....	1,212,000,000	1,083,000,000
	1,054,000,000	572,000,000

The mine and smelter output of lead in the United States in 1921 each fell off about 20 per cent from the 1920 figures.

The output of soft lead by mines of the Mississippi Valley was about 231,000 short tons, and that of argentiferous lead by mines of the Western States was about 170,000 tons, a total of 401,000 tons. The corresponding figures for 1920 are 251,816 tons from the Mississippi Valley (including the small output of the Eastern States) and 259,070 tons from the Western States. The imports of lead in ore were about 7,000 tons, furnished chiefly by Canada, Mexico and South America, and those of lead in bullion were about 41,000 tons, almost wholly from Mexico, as compared with a total of 62,796 tons in 1920.

The output of primary domestic desilverized lead in 1921 was about 190,000 short tons, of soft lead about 145,000 tons and of desilverized soft lead about 55,000 tons, making a total output from domestic ores of about 390,000 tons of refined lead, as compared with 476,849 tons in 1920, which was made up of 220,327 tons of desilverized lead, 189,854 tons of soft lead, and 66,668 tons of desilverized soft lead. The output of lead smelted and refined from foreign ore and bullion was about 50,000 tons, as compared with 52,808 tons in 1920. The total lead smelted or refined in the United States was thus about 440,000 tons, as compared with 529,657 tons in 1920.

ZINC PRODUCTION DECREASES

The mine and smelter output of zinc each declined 60 per cent from last year's figures.

The recoverable zinc content of ore mined in 1920 was about 250,000 tons, as compared with 584,772 tons in 1920. The output of the Eastern States was about 68,000 tons, that of the Central States about 168,000 tons, and that of the Western States about 14,000 tons, as compared with 102,242, 337,652 and 144,878 tons respectively in 1920.

The imports of zinc in ore decreased from 22,487 tons in 1920 to about 2,700 tons in 1921, most of which was imported from Mexico.

The output of primary metallic zinc from domestic ores in 1921 was about 194,000 tons and from foreign ores about 2,500 tons, a total of 196,500 tons, as compared with 450,045 tons from domestic ores and 13,332 tons from foreign ores, a total of 463,377 tons, in 1920. In addition to primary zinc there was an output of about 17,000 tons of redistilled secondary zinc, as compared with 21,371 tons in 1920, making a total supply of distilled zinc and electrolytic zinc in 1921 of 213,500 tons, of which 31,500 tons was high grade and intermediate, 32,000 tons select and brass special and 150,000 tons prime Western. The output of the corresponding grades in 1920 was 114,606, 59,811 and 310,331 tons, respectively, a total of 484,748 tons.

IMPORTS AND EXPORTS OF ZINC

The imports of foreign slab zinc amounted to 6,674 tons, as compared with 15 tons in 1920. The exports of zinc made from foreign ores were about 1,260 tons and those of zinc made from domestic ores were about 3,200 tons, as compared with exports of 28,368 and 85,898 tons, respectively, in 1920. The exports of domestic zinc included about 1,800 tons of sheet zinc, as against 11,852 tons in 1920.

The two largest zinc-rolling mills have added zinc shingle machinery to their equipment. This use of sheet zinc is one of the most promising now being developed.

Brittleness Developed in Aluminum and Duralumin by Stress and Corrosion

Aluminum Is Deeply Corroded Where Impurities Lodge Between Primary Grains, but, if Recrystallized, Is Not Embrittled—Duralumin Is Subject to True Intercrystalline Embrittlement, Starting From Unknown Causes, but Intensified by Corrosion and Stress

BY HENRY S. RAWDON, ALEXANDER I. KRYNITSKY AND JULIUS F. T. BERLINER*

LE CHATELIER¹ has published a description of drink-disintegrated in service by intercrystalline crumbling flasks stamped out of sheet aluminum which bling of the metal. The material, which had a copper content of 3 per cent, cannot be properly designated as "aluminum." By electrolysis in a solution of sodium chloride, it was stated, the aluminum grains were dissolved, leaving unattacked the envelope of the copper aluminum compound (CuAl_2) which surrounded them. Seligman and Williams² have stated that they were unable experimentally to confirm Le Chatelier's observations, although they found that corrosion of overheated sheet aluminum and of the cast metal by dilute sulphuric acid produced somewhat the same effect.

Specimens of metal used as pyrometric standards³ were used in some tests at the Bureau of Standards to determine whether pure aluminum behaved like lead when exposed to combined stress and corrosion.

Chemical analysis of the material gave: Fe, 0.18 per cent; Si, 0.15; Cu, 0.004; Mn, trace; C, 0.01; Co and Ni, not detected, and Al (by difference), 99.66.

Disks, 0.3 in. thick, were cut from a cylinder of cast aluminum, rolled to sheets 0.1 in. thick, and after being cut to size for the test and ground on the surface were annealed in order to remove the effect of cold-working and also to cause recrystallization and grain growth. The specimens used were of the approximate dimensions $4 \times 1.9 \times 0.15$ cm.

As corroding liquids normal solutions of aluminum sulphate and of aluminum chloride were used, together with the same solutions after the addition of the cor-

period of 109 days at room temperature, which varied between 15 and 29 deg. C.

The appearance of the plates after the corrosive attack is, however, more instructive as to the real character of the attack than is its numerical measure in terms of the loss of weight. From Fig. 1, which shows the characteristic appearance of the aluminum plates after corrosion, it is clear that the attack is not uniform over the entire surface. The definite etch-pattern which resulted suggests that the attack of the metal was intercrystalline in character. However, the crystals of the metal are very much smaller than the meshes of the network pattern which the corrosive attack revealed.

The examination of the corroded specimens after grinding off sufficient metal from the surface so that only traces of the etched pattern remained made it evident that the corrosion had been directed by the presence of certain constituents within the metal. These are shown in Figs. 2 to 4 to be without doubt the micro-constituents which existed as films enveloping the crystals in the cast metal and which are the result of the contaminating elements which the aluminum contained, principally iron and silicon. Although the position of these impurities may be changed somewhat by

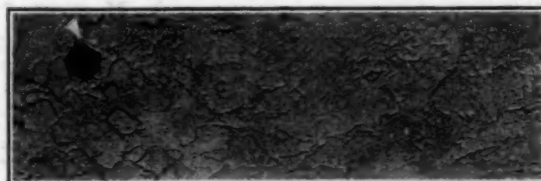


FIG. 1. ANNEALED ALUMINUM SHEET 4 AFTER 109 DAYS IMMERSION. $\times 1$

TABLE I. CORROSION OF PURE ALUMINUM

Spec. No.	Dimensions, Cm.	Area, Sq. Cm.	Corroding Solution	Loss of Wt. After 109 Days, Mg.	Loss per Sq. Cm. per Day, Mg.
1	0.156x1.91x4.07	17.35	N aluminum sulphate	132	0.07
2	0.154x1.78x3.94	15.80	N aluminum sulphate	170	0.099
3	0.152x1.83x3.91	16.04	+ N/4 sulphuric acid N aluminum sulphate	249	0.14
4	0.154x1.78x3.76	15.11	+ N/2 sulphuric acid N aluminum sulphate	320	0.19
5	1.56x1.91x3.94	16.92	+ N sulphuric acid N aluminum sulphate + 2N sulphuric acid	520	0.28

responding acid. The results obtained for the two types of corroding solutions were very similar, so that only the results produced by the sulphate series are given in Table I. Corrosion was permitted to proceed for a

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¹Compt. rend., vol. 152 (1911), p. 650.

²R. Seligman and P. Williams, "The Action on Aluminum of Hard Industrial Waters," *J. Inst. Metals*, vol. 23 (1920).

³Bureau of Standards Circular 66, "Standard Samples for Thermometric Fixed Points."

the distortion of the metal when the alloy is cold-worked, subsequent heat-treatment, short of melting, has no effect upon their distribution, so that a rough record of crystalline structure of the cast metal may be thus preserved in the annealed sheet by the location of these constituents. These impurities so accelerated the attack of the metal adjacent to them that the corrosive pattern produced constituted a record of the previous crystallization rather than that existing in the annealed sheet.

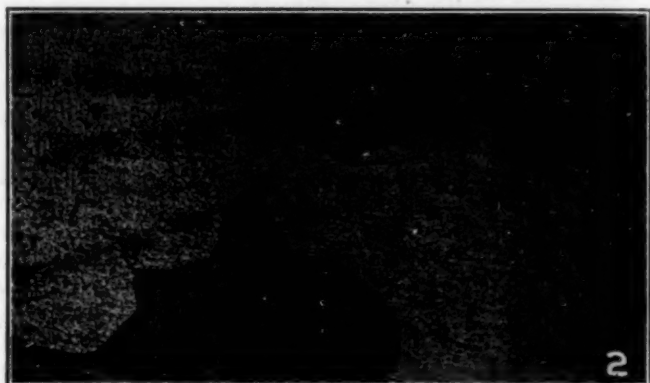
The corroded strips were tested for intercrystalline brittleness by bending them sharply. However, no decided evidence of intercrystalline brittleness such as was reported for lead⁴ was obtained. The surface network pattern appeared to be made up of wide and relatively shallow ditches rather than of narrow and deeply penetrating fissures. If the metal contains a higher percentage of impurities than the material used so

⁴H. S. Rawdon, "Intercrystalline Brittleness of Lead," Bureau of Standards Paper 377.

that the amount of the network constituent is considerably augmented, or if the sheet metal is overheated so that a large crystal size results and the impurities become somewhat intercrystalline in respect to their location, as the grains of the annealed metal approach the size of those formerly existing in the cast metal "intercrystalline" brittleness would be much more likely to occur as a result of a corrosive attack than was the case with the material tested.

EMBRITTLEMENT UNDER SERVICE CONDITIONS

A striking illustration of service deterioration of an aluminum alloy by intercrystalline brittleness was afforded by the examination of some sheet duralumin used as covering material in the elevator of an "all-metal" airplane. The two covering sheets, upper and lower, 0.012 in. in thickness, were of the corrugated type and fastened to each other by aluminum rivets along the



FIGS. 2 TO 4. RELATION OF THE CORROSION PATTERN PRODUCED ON THE SURFACE OF ALUMINUM SHEETS TO THE MICROSTRUCTURE OF THE METAL. $\times 75$

Fig. 2—Cast aluminum. Fig. 3—Same material after reducing in thickness in the ratio 5:1 by cold rolling. Fig. 4—Material of Fig. 3 after annealing so as to cause recrystallization and grain growth. Etching reagent, 8 per cent hydrofluoric acid followed by an immersion in concentrated nitric acid.



FIG. 5. APPEARANCE OF THE EDGE OF A DURALUMIN SHEET WHICH BECAME EMBRITTLED IN SERVICE AS AIRPLANE COVERING. $\times 1$

edge and also to the duralumin tubes inserted between the sheets. A protective lacquer had been applied to both surfaces of the material. Most of the deterioration was localized near the riveted edge of the sheet and, in general, was confined to only one of the sheets; this happened to be the upper one. Portions of the sheet which were embrittled to the extent shown in Fig. 5 were in contact with apparently unchanged material of the other sheet.

When received, a brown deposit was found in spots on the surface of the embrittled sheet, and the surface, after cleaning, had the appearance of having been corroded in such spots, as shown in Fig. 5. The metal was most severely embrittled in the white spots. The characteristic appearance of the deteriorated sheet, as revealed by slightly etching the surface, is shown in Fig. 6. The intercrystalline nature of the attack by which the metal was embrittled is very evident, and the microscopic examination of cross-sections of the sheet demonstrates beyond question that the attack was of this nature. Fig. 7 shows the embrittled sheet without etching; several deep cracks are noted which become jointed together in a network on etching (Fig. 8). Deep corrosion produces the etching pits of Fig. 9, which demonstrate beyond question that the fissures which caused the embrittlement are intercrystalline.

The results of the chemical analysis¹ of the two sheets are given in Table II. The sheet which was most severely embrittled has been designated as B, the other one as A.

TABLE II. COMPOSITION OF DURALUMIN SHEETS WHICH DETERIORATED IN SERVICE

Element Determined	Bottom Sheet A, per Cent	Top Sheet B, Most Severely Embrittled, per Cent
Copper.....	3.40	3.56
Silicon.....	0.19	0.38
Iron.....	0.36	0.40
Manganese.....	0.21	0.29
Magnesium.....	0.54	0.57
(Lead, nickel and zinc).....	Not detected	Not detected
Aluminum.....	95.30	94.80

The two sheets were of essentially the same composition and the results of the chemical analysis suggested no explanation as to the unusual behavior of some of the material in service. The percentage composition of each

¹The authors are indebted to J. E. Scherrer, associate chemist, Bureau of Standards, for the analysis given here.

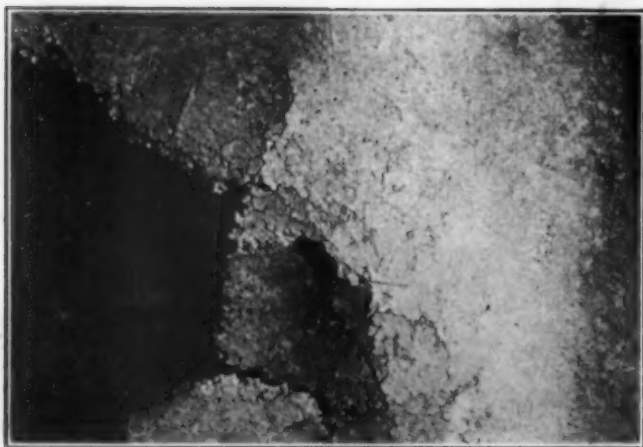


FIG. 6. PORTION OF SPECIMEN SHOWN IN FIG 5, SLIGHTLY ETCHED WITH 10 PER CENT NaOH FOLLOWED BY 8 PER CENT HF. $\times 5$

of the sheets falls within the usual limits for duralumin.*

The mechanical properties[†] of the two sheets as determined by a tension test of portions which appeared to be sound are summarized in Table III.

Both sheets are inferior in their tensile properties to

TABLE III. TENSILE PROPERTIES OF THE DURALUMIN SHEETS EXAMINED

Sheet	Orientation of Specimen	Width of Specimen, In.	Cross-Sectional Area, Sq. In.	Yield Point, Lb./Sq. In.	Ultimate Tensile Strength, Lb./Sq. In.	Elongation in 2 In., per Cent
A (bottom sheet)	Longitudinal	0.782	0.00954	20,500	34,100	8.0
		0.785	0.00958	20,900	35,500	9.5
B (top sheet) . .	Longitudinal	0.774	0.00944	21,200	30,200	4.0
		0.783	0.00955	18,300	24,100	2.0
A (bottom sheet)	Transverse..	0.765	0.00933	24,100	39,500	6.0
		0.760	0.00927	22,100	37,700	5.0
B (top sheet) . . .	Transverse..	0.763	0.00931	26,900	45,100	5.5
		0.764	0.00932	26,900	40,600	1.0
		0.740	0.00903	25,500	30,500	1.5

*Bureau of Standards Circular 76, "Aluminum and Its Light Alloys."

[†]The mechanical testing of the material was done by S. N. Petrenko, associate engineer physicist, Bureau of Standards.

what may be developed in this alloy by proper treatment. The results of the test do not suggest that the material was given any special treatment for improvement of its mechanical properties. The ductility of sheet B, which deteriorated in service, was found to be distinctly lower than sheet A. The most probable explanation for this is that deterioration (intercrystalline embrittlement) had occurred over the surface of the sheet to an appreciable extent. The effect of such an attack of the surface would be to produce numerous microscopic "notches" in the "skin" of the sheet, a feature which would affect the ductility of sheet to a greater degree than the other tensile properties.

ATTEMPTS TO INDUCE BRITTLENESS

The fact that corrosion is of prime importance in producing the embrittlement of the sheet was readily demonstrated by means of a series of corrosion tests. Transverse strips representative of both sheets were cut from the portions which were still ductile and immersed in the following solutions: (1) N/20 aqueous sodium hydroxide; (2) N aqueous aluminum sulphate; (3) N aqueous aluminum sulphate containing N/10 sulphuric acid; (5) N aqueous aluminum sulphate with N/5 acid. Strips $\frac{1}{2} \times 1\frac{1}{2}$ in. were used. Some of these were bent into an arc of a circle with a radius of approximately 1 in. and held in this position by means of a thread tied at each end of the strip. The material was not permanently bent out of shape by a distortion of this amount. Other specimens were immersed in the unstressed or flat condition. It was expected that if intercrystalline embrittlement occurred as a result of corrosion, the network of fine cracks would develop "spontaneously" in those specimens which were corroded while under stress, whereas in the flat unstressed strips such "embrittlement cracks" would become apparent only upon sharply bending the corroded specimen.

The action of sodium hydroxide upon aluminum is a vigorous one even with solutions as dilute as N/20 and it was soon evident that embrittlement of the alloy would not result as a consequence of alkaline corrosion of this kind. The surface of the metal was attacked rather uniformly and at a rapid rate so that the strips became very thin and were covered by a closely adhering black coating. Sharp bending of the corroded speci-

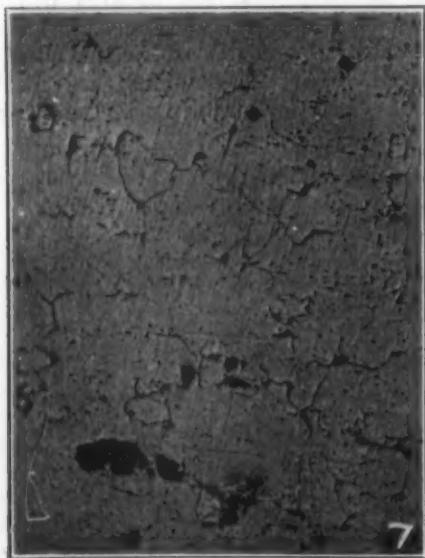
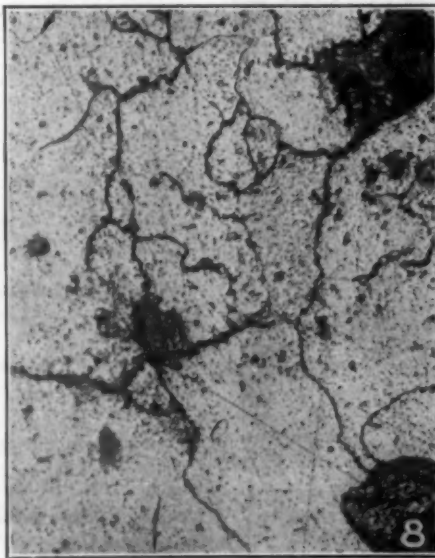


Fig. 7—Embrittled sheet B; unetched. $\times 100$.



FIGS. 7 TO 9
Fig. 8—Same as Fig. 7, etched with 1 to 1 H_2SO_4 with 2.5 per cent $KMnO_4$. $\times 100$.

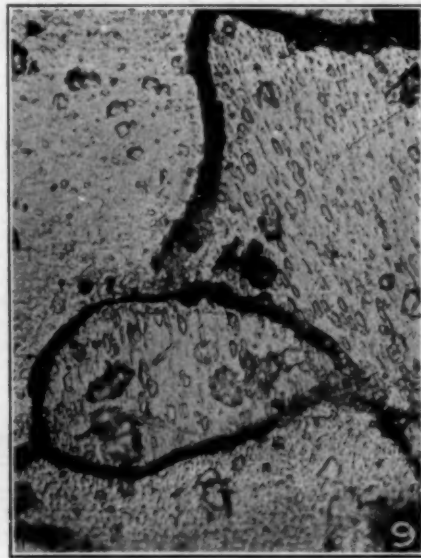


Fig. 9—Fig. 8 at 500 diameters; revealing etching pits.

men after removal of the coating revealed no trace of an intercrystalline attack such as developed in service in sheet B.

The three other solutions closely resembled one another with respect to their corrosion of the specimens immersed in them. The intensity of the attack was approximately proportional to the acidity of the solution. All of the specimens became coated with a black deposit which became brown after standing several weeks in the solution, undoubtedly by the oxidation of the copper which it contained. This deposit resembled, in appearance, that which

was found upon the sheet which deteriorated in service. Fig. 10 is typical of the results obtained with sheet B in these solutions. It represents a portion of a 2-in. strip

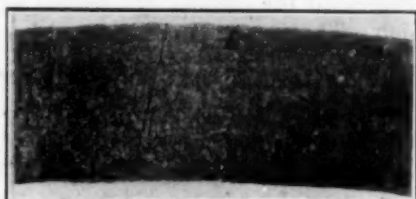


FIG. 10. SHEET B, DUCTILE PART, CRACKED UNDER STRESS AND CORROSION. $\times 4$

from the ductile part of sheet B immersed for 12 days in normal aluminum sulphate solution while simultaneously stressed by being bent into the form of a bow. It was then slightly bent to show the resulting damage. Fine intercrystalline cracks developed in the specimens in a relatively short time. Some of the stressed specimens developed cracks, revealed upon sharp bending, in the acidified solutions in 4 days, and in 12 days' time the

crystalline brittleness was found. Although in some cases, particularly in the acid solutions, the specimens became somewhat brittle as shown by the behavior upon bending the strip, the deterioration appeared to be caused by pitting rather than by an intercrystalline attack. As might be expected, however, the specimens of sheet A, immersed in N/20 sodium hydroxide solution, were attacked in a manner similar to that of sheet B in this solution.

ANNEAL NOT DETERMINING FACTOR

From a comparison of the microstructure of the two sheets (Figs. 11 and 13) it might be inferred that a difference in the annealing which the sheets received was mainly responsible for the difference in their behavior under corrosive conditions, although the tensile properties of the two sheets were not suggestive of any pronounced difference in this respect. Apparently the answer is not so simple as this. Specimens from the two sheets were annealed by us for 2 hours at 410 deg. C., but this did not change their relative behavior upon corrosion.

The theory of Rosenhain* that a metal or alloy in which the crystals have smooth rounded outlines is subject to intercrystalline changes, while the same metal or alloy in a different physical condition whereby deeply interlocking grains result does not seem to answer the question here. It is evident from Figs. 11 and 13 that there is a considerable difference in crystal size, but that the nature of the grain boundaries is not markedly

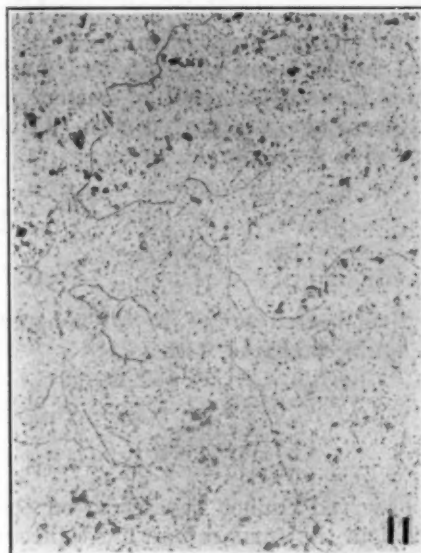


Fig. 11—Ductile portion of sheet B, shown in Fig. 5. $\times 100$. Etched with 1 to 1 H_2SO_4 containing 2.5 per cent $KMnO_4$.



Fig. 12—Embrittlement cracks in metal of Fig. 7 after deeper etching with same reagent. $\times 100$.



Fig. 13—Sound sheet A; etched with 10 per cent NaOH followed by 5 per cent HF. $\times 100$.

FIGS. 11 TO 13

cracks were evident in the stressed specimens in these solutions without bending and in the unstressed specimens upon bending. Some of the stressed specimens immersed in the neutral corroding solution (N aluminum sulphate) after an interval of 12 days showed cracks upon bending, but these were not pronounced until later. After an immersion period of 30 days all of the specimens cut from sheet B, in each of the three corroding solutions, showed well-developed intercrystalline network of "cracks."

The behavior of specimen A was quite different from that of B. After an immersion period of 55 days in each of the three solutions nothing suggestive of inter-

different in the two cases, particularly if the difference in grain size is taken into account.

In general, the results of the tests indicated that a corrosive attack, particularly an acid solution, is a powerful aid in producing intercrystalline brittleness in certain types of duralumin sheet. The results do not warrant the conclusion, however, that corrosion of duralumin always manifests itself by an intercrystalline attack with an accompanying embrittlement of the

*"Introduction to Symposium on the Effect of the Prolonged Application of Stress on Metals," *J. Faraday Soc.*, vol. 16 (April 1921). Also Rosenhain and Archbutt, "Intercrystalline Fracture of Metals Under Prolonged Application of Stress," *Proc. Roy. Soc. London*, vol. A96 (1919), p. 56.

material. The physical state of the alloy and the character of the surface of the sheets appear to be factors of importance which determine the stability of the material when subject to corrosive conditions.

SUMMARY

The nature of the attack in aluminum is determined largely by the amount and distribution of the microstructural constituents which are always present to some extent in commercial aluminum on account of the impurities contained. In the case of cast aluminum, these constituents are intercrystalline in their distribution, but not usually so after recrystallization and grain growth have taken place upon annealing after cold work. Annealed aluminum may, upon being corroded, appear to be attacked in an intercrystalline manner. Examination will often show, however, that the attack was not truly intercrystalline in its nature, but was determined by the presence of certain constituents which existed in the cast metal as intercrystalline lodgments but which, because of a subsequent recrystallization of the metal, no longer coincide with the network of crystal boundaries existing in the annealed metal.

The alloy of aluminum, duralumin, in the form of sheets is subject to a type of deterioration which is truly intercrystalline in character. The rate at which such deterioration progresses can be very much increased by the action of a corroding medium, but the evidence available did not warrant the conclusion that corrosion alone can initiate such deterioration, nor was it evident that the distribution of impurities or microstructural constituents was entirely responsible.

Life Tests of Platinum:Platinum-Rhodium Thermocouples

BY C. O. FAIRCHILD AND H. M. SCHMITT

FOR many years the so-called Le Chatelier thermocouple, consisting of one element of platinum and the other of an alloy of 90 per cent platinum and 10 per cent rhodium, has been known to be the best type of thermocouple for use at temperatures in the range 1,000 to 1,600 deg. C. No other metals or alloys have been found to compare favorably with this combination. The couple does, however, deteriorate quite rapidly when used at high temperatures, and requires frequent replacement or recalibration. The reasons for this have never been thoroughly investigated. Experimenters and other users of thermocouples have frequently observed that thermocouples obtained from different makers or even from the same source do not always exhibit the same rate of deterioration—i.e., time-rate of change of emf.—at any particular temperature. It has been supposed that the couple was particularly sensitive to the slightest contamination and that the variations in rate of deterioration depended primarily upon this fact.

Our attention was first brought to the problem of identifying the causes of the changes in thermocouples by a request addressed to the Bureau of Standards to test the relative efficiency of different types of porcelain protection tubes for thermocouples. Such tests have been deferred until couples can be obtained which are sufficiently free from deterioration under laboratory conditions. The experiments have shown that few thermocouples now in the possession of the Bureau of Stand-

ards will withstand exposure to high temperatures sufficiently well to offer exact means of determining the relative efficiency of different modes of protection.

Thermocouples to be tested were loaned to the Bureau of Standards by manufacturers, with the understanding that the results of the tests would be available for publication by this bureau. There are only two distinct makes of rare-metal couples now on the American market, one of American and the other of English manufacture.

The results of comparative tests, given below, are described for couples designated as American and English. The standard couple used is called P21.

EFFECTS OF EXPOSURE TO HIGH TEMPERATURES

The couples were first carefully calibrated by comparison with a laboratory standard numbered P21 used only for this purpose, and exposed to high temperatures for very short intervals only. The calibrations were made at a depth of immersion of 11 cm. The original values obtained follow:

Millivolts	P21 Deg. C.	American Deg. C.	English Deg. C.
2.00	267	269	264
3.00	375	377	369
4.00	478	480	467
5.00	578	580	559
6.00	674	677	646
7.00	767	771	730
8.00	858	862	811
9.00	946	950	889
10.00	1,032	1,036	965
11.00	1,116	1,120	1,039
12.00	1,199	1,203	1,111
13.00	1,281	1,285	1,181
14.00	1,363	1,367	1,250

After being heated for 18 hours at 1,250 deg. C. in a clean platinum-wound furnace at a depth of immersion of 11 cm. the couples were again compared with P21 at the same immersion, giving results as follows:

Thermocouple	Temperature Indicated, Deg. C.	Error In Pt. Deg. C.	Error In Alloy Deg. C.
P21.....	1,200		
American.....	1,198	0	2
English.....	1,191	0	9

The couples were then heated as before for 6 hours at 1,450 deg. C. and again compared with P21:

Thermocouple	Temperature, Indicated, Deg. C.	Error In Pt. Deg. C.	Error In Alloy, Deg. C.
P21.....	1,200		
American.....	1,194	3	3
English.....	1,186	3	11

Since the effects observed cannot be attributed entirely to contamination in the furnace and must therefore be due in part to elimination of impurities by heating, it appeared desirable to accelerate the removal of impurities by use of a solvent. The following treatment was accordingly applied:

Each couple was heated, in air, at about 1,400 deg. C. by passing an electric current through it, and borax was applied which melted and washed the surface. The borax was then removed with hot hydrochloric acid and the couples electrically heated for 3 hours at 1,500 deg. C. Next the temperature was lowered to about 900 deg. C. and the couples were kept covered with borax applied at frequent intervals for 2 hours. The borax was then dissolved off as before and the couples were heated again for 30 minutes at 1,500 deg. C.

This borax treatment has been used for a number of years at the Bureau of Standards for improving contaminated couples and has been found very effective in rendering the couples more homogeneous. The follow-

ing results were obtained by again comparing the couples with P21 at 11 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	In Pt. Deg. C.	Error In Alloy, Deg. C.
P21.....	1,200		
American.....	1,191	6	3
English.....	1,142	4	54

In order to indicate still more strikingly the difference in the metals, comparison with P21 was made with 6 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	In Pt. Deg. C.	Error In Alloy, Deg. C.
P21.....	1,200		
American.....	1,180	17	3
English.....	1,118	12	70

It would be expected that these couples should show greater changes when tested at 6 cm. immersion, after use at 11 cm. immersion, than when tested at 11 cm. immersion, since in the former position the region of thermo-electric heterogeneity developed by the previous heating is brought into a region of high temperature gradient. It is not evident, however, why the comparatively pure platinum wires of the couple should show a change as great as the equivalent of 17 deg. C.

In these last comparisons the combined effects of the heating and the borax treatment are apparent. To show the effect of the borax treatment alone, comparison with P21 was made at 14 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	In Pt. Deg. C.	Error In Alloy, Deg. C.
P21.....	1,200		
American.....	1,197	0	3
English.....	1,150	1	49

Spectroscopic tests were used to show what impurities were originally present in the metals. The analyses explain the effects described above. The platinum showed in each case traces of calcium. The alloys each showed traces of copper and calcium and the English alloy showed the presence of considerable iron. Chemical analysis resulted in finding iron to the extent of 0.34 per cent in this alloy.

WEIGHT LOSS BY VOLATILIZATION AT HIGH TEMPERATURES

Sections of wire carefully cleaned and heated momentarily to a red heat were carefully weighed and heated electrically in air as follows:

1. Temperature, 1,375 deg. C.; time, 30 min.
Material Loss in Weight, G.
American Pt. 0.00016
English Pt. 0.00016
2. Temperature, 1,450 deg. C.; time, 30 min.
American alloy..... 0.00041
English alloy..... 0.00076
- (a) Continued for 2 hr. at 1,450 deg. C.:
American alloy..... 0.000162
English alloy..... 0.000171
- (b) Continued for 1 hr. at 1,600 deg. C.:
American alloy..... 0.000184
English alloy..... 0.000188

The action is mostly on the surface, such that repeated heatings show decreasing differences. The results are computed for loss per sq.cm. of surface.

The tests described are sufficiently complete for the purpose in mind. They indicate quite plainly that purity of the metals used in making rare-metal thermocouples is of primary importance and that a very high degree of purity is desirable. It is obvious that such impurities as were found, all of which volatilize or oxidize easily, are particularly objectionable.

The platinum has been found to be very good and to compare fairly well with the purest obtainable. No doubt there was some accidental contamination of the

thermocouple, but it is not apparent that this could have materially affected the general conclusions concerning the alloy elements.

CONCLUSION

Tests of thermocouples obtainable on the American market have shown that considerable improvement is desirable, particularly in the English make. The fact that the manufacturers have been able for years to supply thermocouples closely reproducing their thermoelectric standards permits us to infer that the materials used in manufacture of the couples are the same now as they have been in the past. The usefulness of the couples in industrial applications has been proved, though the tests explain some of the faults which have been found during use in manufacturing plants.

The manufacturers of the thermocouples tested have been informed of the results enumerated and are now working to improve their product. The Bureau of Standards will probably repeat the tests in the near future, when better couples have been made.

The Pyrometry Section of this bureau has been aided materially in this work by Dr. E. Wichers of the Chemistry Division and Dr. W. F. Meggers of the Optical Division. Dr. Wichers and his assistants are making a special study of the platinum metals, and Dr. Meggers and assistants are engaged in research in spectroscopy, including its application for quantitative measurement of impurities in metals and alloys.

* * *

Later Tests on English Thermocouple

Subsequent to the completion of the tests reported in the preceding article, the manufacturer of the English rare-metal thermocouple submitted new material to the Bureau of Standards and an additional series of tests was made. It is significant to note that although in the previous tests the alloy wire of this make had been found to contain 0.34 per cent of iron, spectroscopic tests of the new alloy failed to show the presence of iron.

The tests made on the English thermocouple are not comparisons of the English and American makes, and since the conditions of the previous test could not be duplicated exactly, no attempt was made to follow the original procedure. This procedure was, however, adhered to closely enough to prove definitely whether or not the new thermocouples are better than the old thermocouples submitted by the English maker. The results obtained are highly satisfactory, as shown below.

The couples were first carefully calibrated by comparison with a laboratory standard numbered B1. The calibrations and all subsequent comparisons with the standard were made at a depth of immersion of 25 cm. The test couples are designated as L and M, the latter having an alloy of 90 per cent platinum and 10 per cent rhodium and the former 13 per cent rhodium. The original values obtained follow:

ELECTROMOTIVE FORCE VS. TEMPERATURE, DEG. C.			
Millivolts	B1	L	M
2	265	260	265
3	374	363	374
4	478	459	477
5	578	551	577
6	675	639	674
7	769	724	768
8	861	806	859
9	950	886	948
10	1037	964	1034
11	1122	1040	1118
12	1206	1114	1201
13	1289	1186	1284
14	1372	1257	....

This calibration of couple L is different from that of

the couple submitted for the original tests, on account of the elimination of iron from the alloy. This difference will not seriously affect industrial applications, though it amounts to 15 deg. at the higher temperatures.¹

EFFECT OF EXPOSURE TO HIGH TEMPERATURES

After heating for 6 hours at 1,450 deg. C. in a clean platinum-wound furnace the couples were again compared with B1, giving results as follows:

Thermocouple	Temp. Indicated, Deg. C.	In Pt, Deg. C.	Error In Alloy, Deg. C.
B1	1,200		
L	1,199.7	0.3	0.8
M	1,199.4	0.2	0.8

The couples were then heated for 18 hours at about 1,600 deg. C. by passing an electric current directly through them suspended in air, and were again compared with the standard, B1:

Thermocouple	Temp. Indicated, Deg. C.	In Pt, Deg. C.	Error In Alloy, Deg. C.
B1	1,200		
L	1,198	0.7	2.7
M	1,202.3	2.0	0.3

One of the couples was then treated with melted borax as in the previous tests, giving the following results:

Thermocouple	Temp. Indicated, Deg. C.	In Pt, Deg. C.	Error In Alloy, Deg. C.
B1	1,200		
L	1,198	2.1	4.1

At the request of the maker a test in the platinum-wound furnace at 1,500 deg. C. was begun. At the end of 23 hours the couples were removed for comparing with B1, giving these values:

Thermocouple	Temp. Indicated, Deg. C.	In Pt, Deg. C.	Error In Alloy, Deg. C.
B1	1,200		
L	1,197	1.3	4.3
M	1,200.2	0.3	0.1

In order to determine if possible whether or not the couples were undergoing contamination, sections from near the hot junction of couple L were removed and tested spectroscopically. The only result of this test was the identification of rhodium in the platinum. The section removed was far enough from the hot junction to exclude the portion contaminated by welding the junction and to permit the conclusion that rhodium had been volatilized from the alloy and had contaminated the platinum. Apparently the 13 per cent alloy had lost rhodium appreciably faster than the 10 per cent alloy, and the tests were stopped at this point, because results of long continued exposure to the higher temperature would not indicate the quality of the wire, but would be confused with the change due to the transfer of rhodium.

SPECTROSCOPIC ANALYSIS

Spectroscopic tests of the platinum and alloys were made which indicated that both metals were exceedingly pure, very minute traces of calcium and copper being found in each. Re-examination of the spectrograms made in the original tests resulted in finding traces of copper in all the platinum submitted.

The traces of impurities found in the platinum account for most of the changes observed in these tests, but the loss of rhodium from the alloy has prevented any conclusion from being drawn as to the effects of the impurities in the alloys. The Bureau of Standards has been studying the properties of pure platinum and it is now

known that the impurities found cause variations in the thermo-electric properties of the metal to approximately the extent noted in these tests, and it is highly probable that such quantities of impurities can slightly affect the refractoriness of the alloy. However, the alloy of couple M remained remarkably homogeneous throughout the tests.

CONCLUSION

The original tests of the English and American makes of thermocouples revealed that the former deteriorated too rapidly when exposed to high temperatures; and the tests showed that this trouble was caused mainly by iron in the English make of alloy. The English maker has improved his products, and as a result rare-metal couples conforming to the high emf. standard can now be obtained, which will be satisfactory for use at high temperatures. The latter type of couple will now be known as a 13 per cent alloy couple. This 13 per cent alloy has a thermo-electric power against platinum of approximately 14 microvolts per degree at 1,200 deg. C., while the 10 per cent alloy gives but 12 microvolts per degree at this temperature. The tests indicate that the 10 per cent alloy is more refractory than the 13 per cent alloy, but, as shown above, a total change of only 4.3 deg. due to change in this alloy alone was found after the very severe treatment received.

For industrial use the rare-metal couples now obtainable are sufficiently refractory to direct attention once more to methods of and materials for protection. Adequate protection from furnace gases and vapors at 1,450 deg. C. and upward is still lacking. A more refractory porcelain is wanted and one which has been fired and vitrified at a temperature of not less than 1,550 deg. C.

Bureau of Standards,
Washington, D. C.

National Safety Council Compiling Census of Safety Workers

The National Safety Council is undertaking the compilation of a census of all persons engaged in safety and industrial health activities. The chemical industry has, because of inherent hazards of its nature, always been among the leaders in industrial safety, but it has never been established definitely how many persons in the chemical industry are engaged in accident prevention and industrial health work, or how this industry compares with other industries in this respect.

Industry in general and the nation at large will profit from the results of this census. It will enable the Council quickly to find speakers on industrial and public safety for any occasion in any locality; authors for special articles on accident prevention; writers of safety textbooks; lecturers on accident prevention and industrial health work for universities and colleges. The Council at present continually receives requests from industrial companies, municipalities, civic associations, clubs, schools, colleges and other organizations for help in finding speakers or writers on safety subjects. The census records will greatly increase the facilities of the Council for filling such requests.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work—whether he is devoting all or only part of his time to accident prevention—is urged to assist in the taking of this census by sending his name to the National Safety Council, 168 North Michigan Ave., Chicago.

¹See Bureau of Standards Tech. Paper 170 for mean calibration of a large number of couples of this type submitted to the bureau for testing.

Explosives and Fertilizers*

A Broad Economic View of the World's Resources Indicates That Our National Defense, Our Future Food Supply and Our Continued Industrial Pre-eminence Depend on Nitrogen Fixation and the Maintenance of Chemically Trained Personnel

By ALFRED H. WHITE

Professor of Chemical Engineering, University of Michigan

THE intimate connection between explosives and fertilizers has been well known to the scientific world, but the roar of the stupendous explosion at Oppau in Germany a few months ago has perhaps accentuated it and has certainly brought vividly to the lay mind the possibility of the use of the same material for the two widely differing purposes. The mechanism of that unexpected explosion, which blotted out four hundred lives, is still a matter of conjecture, but it seems clear that a warehouse reported to contain 7,000 tons of a mixed salt of ammonium nitrate and sulphate, intended perfectly legitimately for fertilizer and believed to be entirely safe, unexpectedly exploded with all the violence of a high explosive.

The battle of Crecy has been famous for nearly 700 years, not so much because of the victory which the English won as because of the introduction of gunpowder and artillery as a decisive factor in warfare. It has been recognized for centuries that superiority in explosives and artillery was one of the strongest assets of a contending nation. As Napoleon cynically phrased it, "God is on the side of the heaviest artillery." Our own country has been hampered in all its major wars by lack of sufficient explosives. The Continental Congress urged the colonists in the days of the Revolution to make niter plantations to supply the nitrate needed for gunpowder. During the war of 1812, the earthen floors of Mammoth Cave in Kentucky were leached for the meager supply of nitrates stored therein. In the Civil War the armies of the North were not nearly so hard pressed as those of the South, but many of the battles came to a standstill through exhaustion of ammunition. We remember the desperate state of the British armies in Flanders in 1914 and 1915, when they were subjected to the withering fire of the German batteries without even the possibility of an effective reply.

THE ALLIES' DEMANDS FOR EXPLOSIVES

When we entered the war, in 1917, the first demand made upon us was for explosives. This was emphasized at the meetings of the Interallied Council in the fall of 1917, when it was brought out that during the year 1918 Great Britain and France could supply artillery for all of our troops, as well as theirs, but that they were in desperate need of explosives for their own troops. They specifically requested "that the American efforts shall be immediately directed to the production of propellant and high-explosive powders on the largest possible scale." The reason for this shortage of explosives in France and Great Britain is found in the lack of raw materials in these countries. We think of smokeless powder as requiring cotton, nitric and sulphuric

acids, and alcohol; and of the high explosives as requiring ammonium nitrate together with toluene, sulphuric and nitric acids, but the fact which escapes our attention is that the raw material whose tonnage is greatest is one that does not appear at all in the finished product. It is coal. Each pound of smokeless powder requires 9 to 10 lb. of coal. The French had to import from 8 to 12 tons of raw materials for each ton of high explosives, and from 15 to 20 tons of raw material for each ton of smokeless powder. The expenditure of explosives during the World War was on a scale undreamed of before that time. Our American artillery, in its preparation for the attack on the St. Mihiel sector, fired two-thirds as many rounds of ammunition in 4 hours as the Union forces fired in 4 years during the Civil War.

The response that we made to our allies' demand for explosives was a striking proof of the ability of this country to undertake large operations. Fortunately, most of the raw materials were present in abundance. Coal, cotton, alcohol and sulphuric acid were obtainable in ample quantity. The production of toluene had to be stimulated, but the process of manufacturing it from California petroleum, which was developed to meet the emergency, was capable of furnishing many times more than the needed amount. The greatest shortage of material was in fixed nitrogen, especially in the form of nitric acid. The main source of the world's nitrate was in Chile, separated by a long ocean voyage from this country and from Europe, and the submarine campaign called for the diversion of every possible ship to carry troops and supplies to France. There was no certainty whether it would be possible to maintain the shipment of the amounts of nitrate required, nor indeed whether Chile would remain neutral and willing to furnish us the raw material. Germany had foreseen that any war which involved Great Britain would immediately cut her off from supplies of nitrates, and she had guarded against this contingency, first by a large reserve stock, and second by the development of processes for fixation of the nitrogen from the air, which would render her independent of outside supply.

NITROGEN PREPAREDNESS—1914 AND 1922

Germany's success in her nitrogen fixation program is a matter of common knowledge. She built plants which supplied her army with munitions and her soil with at least a part of its normal supply of fertilizer. No other country had deliberately planned for war, and so no other country had subsidized the development of this industry of nitrogen fixation. The ammonia from the coke ovens in the allied countries was entirely inadequate for the emergency, and England, France and the United States all worked feverishly to install

*A contribution to the Symposium on Chemical Engineering and National Defense presented before the Baltimore meeting of the American Institute of Chemical Engineers, Dec. 6, 1921.

fixation plants. These could not be built in a day and so the armistice came with the most of the plants uncompleted.

At the close of the war Germany had as assets her plants, whose construction cost had already been largely amortized. They have been merged into one immense combination with government assistance, so that they are in a position to act as a unit and expend their energies where they are needed. In our own country the unfinished plants were scrapped and only two were retained. U. S. Nitrate Plant No. 1, built to produce ammonia by direct synthesis of nitrogen and hydrogen under high pressures—a modification of the Haber process—was not entirely successful in its operation. U. S. Nitrate Plant No. 2, at Muscle Shoals, built to fix 41,000 tons of nitrogen a year by the cyanamide process, was a pronounced success. Both these plants are being maintained in a standby condition pending final decision by Congress as to their method of operation, if indeed they are to be operated at all. Other developments during and since the war have contributed to make our condition of nitrogen preparedness much better than it was in 1916. The stimulation in construction of byproduct coke ovens has doubled the amount of ammonia which may be produced in the United States from this source. Methods for oxidation of ammonia to nitric acid were developed during the war. Provided our country maintains a reasonable stock of nitrate of soda as a military reserve, these sources of ammonia production should permit us to supply the needful explosives for a defensive war. If, however, we were to be drawn into another such terrific cataclysm as that of 1914-1918, we would again be forced to construct new fixation plants.

DEVELOPMENT OF NITROGEN FIXATION PROCESSES

If we had to face another such emergency, we would be better prepared, for the processes of nitrogen fixation are much better known than they were when we entered the war. The cyanamide process had been well developed before the war both in Europe and at Niagara Falls, and the plant at Muscle Shoals, designed by the American Cyanamid Co., represents the most advanced construction in these lines. The other important process for nitrogen fixation, the Haber process and its variants, reached a high development in Germany during the war. The one plant attempted in this country and constructed with government funds at Sheffield, Ala., failed to operate satisfactorily. But the same private interests that designed this plant have, with the experience gained through the first venture, designed and constructed a plant at Syracuse, N. Y., which is said to be producing 12 tons of anhydrous ammonia per day and to be operating very smoothly and satisfactorily. In case it becomes necessary for the government to construct synthetic ammonia plants, there is a pilot plant with trained personnel, whose services would undoubtedly be made available to the government for the national defense.

From France comes the report that the famous French engineer M. Georges Claude has been successful in his daring attempt to produce ammonia synthetically, not at pressures of 100 atm., or even 250 atm., but at pressures of 1,000 atm. This process, which works with flammable gases in steel containers at red heat under pressures which are almost half of those set up in a cannon when fired, is certainly one of the most remarkable that has ever been attempted, and the success of

M. Claude is further evidence that he is a chemical engineer of the very highest type.

It appears then that from the standpoint of raw materials for explosives our country is fairly well prepared for national defense. The one raw material which has been lacking, fixed nitrogen, is now provided in reasonable amounts from our coke ovens, with the government plant at Muscle Shoals as an immediate reserve and at least one private plant for direct synthesis of ammonia in successful operation.

IMPORTANCE OF MAINTAINING TRAINED PERSONNEL

Raw materials are, however, only one of the things needed for explosives. Even more essential is the knowledge of manufacturing processes which exists only with the maintenance of a trained personnel. It is probable that commercial explosives will always be manufactured in this country, and it may therefore be argued that there will always be an adequate nucleus of a personnel for war needs. But is it probable that the manufacturers of commercial explosives will be leaders in the development of new materials which might be used in warfare? What kind of explosives will be used in the next war? The only answer which we are warranted in giving at the present time is that they will be unstable chemical compounds which must be synthesized with very great care and will almost certainly be complex organic compounds. The one type of factory which is always working with this form of synthetic organic compounds is that which manufactures dyes.

The connection between the dye industry of the country and the manufacture of poison gases has been frequently discussed. The relation between the dye industry and explosives has not been emphasized so much, and yet the operations of nitration are fundamental both to the dye industry and to the manufacture of explosives, and certain materials such as picric acid and dinitrophenol are in themselves explosives as well as products of the dye manufacturer. The relation of explosives to poison gas is so very close that it is not possible to say with certainty where one begins and the other leaves off, and I cannot refrain from giving one specific instance of the ready adaptation of a dye works to the manufacture of poison gas.

DEMONSTRATING THE IMPOSSIBILITY OF CHEMICAL DISARMAMENT

The Badische Anilin- und Soda-Fabrik of Germany has a capacity to produce 800,000 lb. of indigo each month. Its process starts with alcohol, which is converted into ethylene and then into ethylene chlorhydrin. This latter product is heated with aniline and the oily residue is fused with caustic potash; indigo is at once obtained from this fusion by solution in water and oxidation by air. Were Germany to be drawn into war, this plant might be converted into a mustard gas plant in scarcely an hour's time. The first two steps in the process are identical; in the third step, sodium sulphide, a cheap chemical, is substituted for aniline and the solution thus obtained is concentrated and treated in large tanks with hydrochloric acid. The oily product settling out at the bottom is the well-known mustard gas, and may be drawn off at will.

This instance of the adaptation of a dye works to war purposes is cited partly to show the impossibility of chemical disarmament. Any nation which permits its dye industry to perish is in danger of destruction

by an enemy which is prepared to unmask these terrible agencies of destruction. These industries play an important part in our modern industrial organization, and unless the world is willing to do without colors and also synthetic medicinal products, these plants cannot be wiped out. The only safe protection appears to be in an equality of preparedness.

PREPAREDNESS FOR PEACE

Let us turn our attention from preparedness for war to preparedness for peace—to the measures necessary to maintain the fertility of the soil. The importance of the subject has been well summed up by Theodore Roosevelt, who, writing in the *Outlook* in 1912, said:

I have always been fond of history and of science, and what has occurred to Spain, to Palestine, to China and to North Africa from the destruction of natural resources is familiar to me. I have always been deeply impressed with Liebig's statement that it was the decrease of soil fertility, and not either peace or war, which was fundamental in bringing about the decay of nations. While unquestionably nations have been destroyed by other causes, I have become convinced that it was the destruction of the soil itself which was perhaps the most fatal of all causes.

One of our most eminent American agriculturists, the late Dr. C. G. Hopkins of the University of Illinois, showed in 1909 that one of their experimental fields which had been carried on crop rotation for 7 years without fertilization decreased in fertility so that the crop of corn fell from 57.3 bu. to 33.9 bu., and oats decreased from 74.4 to 25.9 bu. per acre. A check plot fertilized by addition of nitrogen and phosphorus increased its yields of corn over that given in the earlier years, and gave a crop of oats which, while not so large as in the first year of the test, was still 20 bu. greater than that given by the unfertilized plot.

The same authority cited the case of Russia, where the average annual yield of wheat for 20 years is 8½ bu. to the acre and where a decrease of only 2 bu. to the acre means a famine. He gave the following solemn warning, which is strikingly similar in import to that of President Roosevelt cited above:

With the exception of a few small countries, the record of our race is a record of ruined lands; and if we repeat, in the great corn belt of America, the history of the white race in Palestine, in southern Europe, in Russia and in the eastern part of the United States, where shall our children go for bread?

We in the United States are accustomed to think of our soil as a permanent asset, just as a generation ago we considered our petroleum, natural gas and coal as permanent assets which did not need to be conserved. Yet the evidence is clear that even our richest soils are deteriorating. The State of Illinois is on the whole one of the richest farming states in this country, and yet Dr. Hopkins has stated that if continuous crops of corn of 100 bu. per acre were grown on the Illinois farm lands, the supply of phosphate in the soil reached by the plow would be not diminished but totally exhausted in from 51 to 105 years. A corn crop of 100 bu. requires for the grain alone 100 lb. of nitrogen. Some of the poorer farm lands of Illinois contain only sufficient nitrogen in the surface soil for forty-six crops of this sort and none except the deep peat soils contain enough nitrogen in the surface soil to last more than 67 years. It is recognized that phosphates and other mineral fertilizers in some form must be added to the soil if its fertility is to be maintained. The nitrogen problem is, however, of more importance. The Illinois Agricul-

tural Experiment Station states: "The nitrogen problem is the most important practical problem confronting the American farmer."

THE NITROGEN PROBLEM IN AGRICULTURE

Although there is agreement among agriculturists and scientists as to the seriousness of the nitrogen problem in agriculture, there is not the same unanimity as to the best means of maintaining the nitrogen content of the soil. The early Roman writers on agriculture knew the value of leguminous crops as restoratives of soil fertility. The system of maintenance of a permanent system of soil fertility by proper rotation of crops and utilization of plant residues forms the basis of the system advocated by Dr. Hopkins for Illinois soils. However, the system requires more than the usual care, for their bulletin states:

The nitrogen of the soil, therefore, cannot be maintained simply by incorporating a legume in the rotation, as is too often assumed. The proper utilization of the legume hay produced, and the return of its nitrogen to the soil, is a problem of utmost practical importance.

The use of a legume cover crop in wheat and oats also plays an important part in maintaining the nitrogen supply of the soil. The legume so used is probably of more importance really than its occurrence in the regular rotation.

It has been proved that the nitrogen content of soil such as that of Illinois can be maintained without addition of a commercial fertilizer, provided sufficient attention be paid to the biological processes. The question is not, however, decided for other types of soils and other methods of farming, and it is not settled whether the maintenance of the nitrogen content of soil through legumes is as economical as its partial restoration through commercial fertilizers. This is a question which can be answered only by a careful economic study and one which from its nature will have to be reconsidered with every variation in the cost items which enter the computation. The recent increase in the value of farm lands and in farm labor has made it necessary to recast pre-war figures.

Investigations made by the Farm Management Department of the Iowa State College of Agriculture, in co-operation with the Iowa Farm Bureau Federation in 1920, showed that the average direct cost of growing an acre of wheat in Iowa was \$18.19, of which almost exactly 50 per cent was labor and less than 10 per cent was charged to fertilizer. It may be noted that this fertilizer was merely manure and undoubtedly entirely inadequate to replace the nitrogen lost in the crop. The point to be emphasized is that this typical acre which produced 18.5 bu. of wheat had expended upon it \$18.19 as direct charges, to which was added the figure of \$16.80 for land charges, so that according to the computation the total cost of wheat was nearly \$1.90 per bushel. Almost one-half was a fixed charge due to the land.

METHODS OF NITROGEN REPLACEMENT

The Illinois system of permanent soil fertility as advocated by Dr. Hopkins dispenses with the use of commercial nitrogenous fertilizers, but gives no return at all to the owner of the soil during the fourth year, when the land is wholly given over to the cultivation of clover, which is to be plowed under and from which not even hay is to be cut. If the direct cost of caring for the land during this year is estimated at only \$5 per acre and the land charge is to be \$16.80 per acre, as

estimated in the Iowa figures given above, it will mean that the cost of this method for replacing the nitrogen in the soil is \$21.80 per acre. If nitrogen in fixed form may be purchased by the farmer at 15 cents per lb., he could buy 145 lb. for this sum, and if nitrogen could be purchased by the farmer at 10 cents per lb., which is not at all an impossible figure, he could buy 218 lb. of nitrogen. This would provide for the nitrogen removed by 218 bu. of corn, so that theoretically the farmer could grow a heavy crop of grain every year and possibly be better off financially than if he kept up the nitrogen content of his soil wholly by clover or other leguminous crops. The advantage to the nation is evident, for the product of the land during every year, instead of only three years out of four, would add a potential one-third to our crop production.

THE CHEMICAL ENGINEER'S RESPONSIBILITY

It is not for the chemical engineer to decide what method of nitrogen replacement is best from the agricultural standpoint. It is proper for him, however, to consider how far he might meet a demand if it were made upon him.

The combined crops of wheat, oats and corn in the United States amount roughly to 5,000,000,000 bu. annually. Each bushel removes from the soil about 0.9 lb. of nitrogen, so that the total annual loss of nitrogen from the soil in the grains alone is 4,500,000,000 lb., or 2,250,000 tons, of nitrogen. This is not an exorbitantly high estimate. Dr. Lipman, director of the New Jersey Agricultural Experiment Station, was quoted in the hearings before the Senate Committee on Agriculture and Forestry (Senate Document 3,390) as having estimated that the total annual loss of nitrogen from all land under cultivation in the United States, after making allowance for all returns to the soil, was between three and four million tons.

These figures are staggering, but the authority is good. Let us assume that we must return to the soil through commercial fertilizers, not the larger figure of 4,000,000 tons, but the smaller figure of 2,250,000 tons representing the loss in the grains alone. The tankage, cottonseed meal and other organic compounds now used account for only 4 per cent of this amount and their total is decreasing rapidly. The coke ovens and private plants for nitrogen fixation in the United States would make up less than 5 per cent. Imports of Chilean nitrate in the same amount as used for fertilizer before the war would furnish only 2 per cent. There is lack of agreement as to the future life of these Chilean nitrate deposits, just as there is lack of agreement as to the number of years before our petroleum resources in the United States will be exhausted. There is, however, general agreement that the life of both resources is limited and that within one generation, or at most two generations, substitutes will have to be sought for the large uses of both these materials.

The organic wastes, coke-oven ammonia and Chilean nitrates might together account for perhaps 11 per cent of the 2,250,000 tons of nitrogen called for annually to replace that removed from the soil by the grain crops. The remaining 2,000,000 tons would have to come from fixation processes.

There is only one really large fixation plant in the United States—that owned by the Government at Muscle Shoals. It has a capacity for fixing 41,000 tons of nitrogen per year, but it would require forty-nine such plants to provide the nitrogen called for. Nitrogen fixation on

this tremendous scale at a price which will render the product available for fertilizer is entirely impossible with our present technical developments. But is the prospect of such a demand merely a wild dream?

It was Sir William Crookes who twenty-three years ago, in his presidential address before the British Association for the Advancement of Science, first called the world's attention to the probable exhaustion of the nitrogen of the soil throughout the world. I quote from his address:

Gradually all the wheat-bearing land on the globe is appropriated to wheat growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average, 12.7 bu. per acre, to a higher average. To do this efficiently and feed the bread eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extreme slowness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence. . . . The fixation of nitrogen is vital to the progress of civilized humanity. Other discoveries minister to our increased intellectual comfort, luxury or convenience; they serve to make life easier, to hasten the acquisition of wealth or to save time, health or worry. The fixation of nitrogen is a question of the not far distant future. Unless we can class it among certainties to come, the great Caucasian race will cease to be foremost in the world and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

This solemn warning aroused the scientific world to the importance of nitrogen fixation, but after nearly a quarter of a century it is only a few in our nation who appreciate the vital importance of this problem.

OUR NATIONAL AND INDUSTRIAL PRE-EMINENCE DEPENDENT ON FIXED NITROGEN

This discussion of the question of fertilizers and explosives has hinged largely on the question of supply of fixed nitrogen. From the military standpoint, our situation is much better than in 1917 and it would seem that our coke ovens with their increased production and the private plants for nitrogen fixation, with the government plants standing as a reserve, are sufficient to provide explosives for national defense.

The maintenance of our soil fertility stands out as a far larger problem. The United States will have to struggle to maintain its industrial pre-eminence and its high standards of living in the face of decreasing natural resources. Our soil fertility has been our greatest asset. As New England farms became unproductive, their occupants moved to the Ohio and Mississippi valleys, where the soil produced in as rich a measure as the world has ever known. Even these marvelous soils are deteriorating.

The elements taken from the soil must be put back into it. The most important single constituent is nitrogen. Agriculturists have shown that it is possible to replace this by a system of crop rotation, but it involves an absolute lack of return from the soil during every fourth year. The increase in the value of farm lands has greatly increased the expense of this process through the increase in fixed charges and has correspondingly increased the opportunity of the chemical engineer to produce fixed nitrogen at a price which can compete with this method of fertilization through biological processes.

The principles of nitrogen fixation are clearly outlined, but the developments are still in their infancy. The process of the synthesis of ammonia through direct

combination of nitrogen and hydrogen presents possibilities and difficulties which challenge the best efforts of our chemical engineers, for this process has been called the most difficult chemical engineering operation which has ever been undertaken. The fixation of nitrogen can be accomplished as a military measure. Can it be accomplished so economically that it can produce the nitrogen needed by this country to maintain its soil fertility? That remains for the future.

In our study of national preparedness, we may list the raw materials for explosives as adequate, but the personnel which is to guide the future development is largely dependent on the fate of the dye industry and its related industries which deal with synthetic organic chemicals. The importance of a far greater supply of nitrogenous fertilizer is hardly yet recognized. The agriculturist through crop rotation and biological processes can meet the need in part. Can the chemical engineer develop the processes of nitrogen fixation so that the soil will remain productive and our children and our grandchildren live as comfortably as we do?

History shows that the fallen nations of the world either perished from exhaustion of the soil or were conquered by a hardier race after they had lost much of their original vigor through too much prosperity or indulgence. In either case they had failed in national preparedness. It was pardonable in the days of the dawn of civilization. It will be unpardonable if we, with our knowledge of the mistakes of the past and with the powerful weapons of modern science in our hands, make the same mistakes.

Fusibility of Open-Hearth Slag Containing Titanium Dioxide

By GEORGE F. COMSTOCK

Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

THE comparative fusibility of basic open-hearth slags from soft steel heats and of similar slags with small additions of titanium dioxide has recently been investigated in the physical laboratory of the Titanium Alloy Manufacturing Co., with interesting results. Two slags were used in this work, one from the Wickwire-Spencer Steel Corporation in Tonawanda, N. Y., and the other from the National Enameling & Stamping Co. in Granite City, Ill. The former had a very much lower melting point than the latter, so that it could be melted in a coke fire, while with the latter this method was impracticable. The experiments with the low-melting Wickwire slag will be described first.

This was melted in small crucibles in a coke fire, two No. 12 Dixon graphite crucibles and one old crucible of about the same size, formerly used for bronze, being consumed in these trials. The corrosive action of the slag and the high furnace temperatures required for the melts caused the crucibles to wear out very fast. Plain crushed slag was first melted and taken out in the furnace to cool in the air, while various methods of determining the freezing point were tried. Owing to the viscous consistency and poor thermal conductivity of the slag, this determination was a much less simple matter than a similar determination is with metals. The slag passes very gradually from the liquid to the solid state through all stages of plasticity, and during cooling no two layers in the crucible are at the same temperature. Consequently a thermocouple inserted in the cooling slag gives a series of gradually decreasing readings, with any stationary period such as denotes the freez-

ing point of a metal. It was planned therefore to note the progress of solidification by visual observation while stirring the slag, using a thermocouple and an optical pyrometer to give temperature measurements when the slag seemed to be just solid.

In the first trial, a nichrome tube closed at one end was inserted into the slag in the furnace and heated until all was at a uniform temperature, and the pot with the tube in it was withdrawn and permitted to cool. A quartz tube containing a platinum thermocouple was inserted in the nichrome tube, and the slag was stirred till it solidified, while readings were also taken on the liquid slag with the optical pyrometer. By this method the freezing point was determined as 1,175 deg. C. by the thermocouple and 1,115 deg. C. by the optical pyrometer. But on removing the thermocouple the quartz tube was found to be contaminated by slag, as the end of the nichrome tube had been burned off. A new iron tube was tried, but did not last any better, so finally a graphite tube had to be used. In another trial both pyrometers agreed fairly well on a freezing point at 1,110 deg. C.

A next trial was made with powdered slag to which 0.33 per cent TiO_2 was added, which was intended to represent the proportion of titanium which the slag would acquire by the total oxidation of the usual 3 lb. per ton addition of ferro carbon-titanium in soft steel. This addition would amount to about 0.5 lb. of titanium, or roughly 1 lb. of oxide per ton of steel, while the slag made was estimated at 15 per cent, or 300 lb. per ton, of steel. The mixture of 1 part TiO_2 to 300 parts slag was melted four times, and temperature measurements were made on it each time it cooled. The thermocouple in the carbon tube did not prove a very satisfactory arrangement, however, as the slag froze around it and it interfered with stirring because it could not be moved freely with the pyrometer wires and quartz tube in it. Also the optical readings on the slag itself were unsatisfactory, because the surface of the melt was always cold, and even when the skin was broken the hot liquid became covered at once with a cooler film before a reading could be taken. Consequently the best plan seemed to be to use the graphite tube as a stirrer, without any thermocouple in it, and to get the temperature measurements by sighting down into its hot end with the optical pyrometer. This method probably gave slightly low readings on account of the loss of heat from the hot end to the colder top of the tube, but it was convenient in operation and seemed to give concordant and regular results. All further trials were made in this way.

Such observations on the 0.33 per cent TiO_2 mixture described above showed a freezing point of about 1,085 deg. C. The crucible was thoroughly cleaned out after this trial, and another melt of the plain slag without titanium was made by the same method. Three tests in this way gave an average reading of 1,085 deg. C., showing that the addition of 0.33 per cent TiO_2 had no appreciable effect. In both these trials considerable white cast iron was reduced from the slag by the carbon of the crucible and tube during the repeated meltings, and the crucible was entirely used up at the end of this trial. No way of avoiding the reduction of iron from the slag could be thought of, with the melting facilities available.

Two separate trials, each consisting of several remeltings and in different crucibles, were made of this slag mixed with 1.33 per cent TiO_2 , the proportion assumed to

be acquired from the recommended addition to rail steel. These trials resulted in freezing points of 1,060 and 1,055 deg. C., respectively, being found. Another trial was made with twice as much TiO_2 , giving a result of 1,025 deg. C. Thus it seems that larger quantities of TiO_2 do indeed lower the melting point of basic open-hearth slag, and the slags from these latter trials were noticeably thinner when hot and more glassy when cold.

A final trial of the plain slag to check the first result of 1,085 deg. C. was made, and a lower result—namely, about 1,065 deg. C.—was obtained. It was noticed on the last few trials that after the first melting the slag generally showed a comparatively high solidification temperature, while on subsequent meltings it remained liquid when colder. It is believed that the slag as received was in a chemically unstable state, with certain compounds incompletely formed, and that a considerable period of fusion and quite a high temperature are required to complete these reactions. This condition would involve various uncertainties in the action of titanium dioxide on the slag in open-hearth practice, for the results would depend on the exact condition of the

TABLE I—SOLIDIFICATION POINTS OF SLAG FROM WICKWIRE-SPENCER CO.

	Deg. C.
Plain slag.....	1,065 to 1,085
Slag with 0.33 per cent TiO_2	1,085
Slag with 1.33 per cent TiO_2	1,055 to 1,060
Slag with 2.67 per cent TiO_2	1,025

slag when this oxide entered it and the time available for combination to take place before freezing. In view of these uncertainties arising from the unstable and probably irregular composition of the slag, its viscosity and low thermal conductivity, the results described above are probably as accurate as it is worth while or possible to get them. They may be summarized in Table I.

Results on this slag indicate that titanium dioxide increases the fusibility of basic open-hearth slag, but not unless it is present in amounts greater than that available from the usual alloy addition to soft steel. If it may be assumed, however, that all the titanium is oxidized in the steel, and this oxide combines first with the slag particles included in (not resting on) the liquid steel, almost any percentage of TiO_2 might be present in these particles from a very small total titanium addition to the bath. Thus the fact that 2 or 3 per cent of TiO_2 made quite a noticeable improvement in the fusibility of this slag may be of practical interest and importance, even though the entire slag from a titanium-treated open-hearth heat may never reach this comparatively high TiO_2 content.

The other slag sample available, from Granite City, could not be melted by the coke fire, so that a different method had to be used with it. The only other method which appeared practicable with the heating equipment available involved making briquets or cones of the crushed slag, standing them up on a magnesite brick in a small reverberatory furnace which could be made very hot by two high-pressure oil burners, and noting with the optical pyrometer the different temperatures at which they sagged or bent over when softened by the heat.

A trial of this method having been decided upon, a mold of steel was first made for the briquets, which were to be in the form of a rectangular wedge, with sides 2 in. high and ends in the form of equilateral triangles of $\frac{1}{2}$ in. base. The granular material for the briquets was moistened with a dilute solution of dextrine to act

as a binder, and packed in the mold, which was previously lined with paper to prevent sticking. Twenty to fifty thousand pounds pressure was applied to the mold in forming the briquets, but they were not very firm until after drying. This operation was performed over night at about 100 deg. C. and the next morning they were hard enough to stand handling readily.

The first trial of this method showed that it was necessary to grind the slag to at least 100 mesh in order that the briquets should be sufficiently resistant to cracking or spalling in handling and heating and that the dried briquets must be dressed to an exact size and shape to insure proper comparative results in the furnace. These precautions were taken therefore in the experiment with this slag, and two briquets were made without any addition and called No. 1; two others, with 0.33 per cent TiO_2 , were called No. 2; two others, with 1.33 per cent, No. 3; and finally two with 4 per cent TiO_2 , called No. 4. These were all stood up on a level magnesite brick in the oil-fired furnace, with bricks placed behind to protect them from the direct blast of flame. The temperatures were taken with an optical pyrometer.

The No. 4 briquets began to bend at 1,285 deg. C., and one failed at 1,305, the other at 1,325 deg. C. The No. 3 began to bend at 1,333 deg. C., failing at 1,348 and 1,358 deg. C., respectively. The No. 2 began to bend at 1,360 deg. C. and bent over completely at 1,373 and 1,377 deg. C., respectively. The No. 1 briquets began bending at 1,385 deg. C., and one failed at 1,418 deg. C., while the other remained upright, but was considerably melted down at 1,458 deg. C., when the furnace was shut down. These results, tabulated in Table II, are

TABLE II—TESTS OF BRIQUETTED SLAG FROM NATIONAL ENAMELING & STAMPING CO.

	Beginning of Bend, Deg. C.	Failure, Deg. C.
Plain slag.....	1,365	1,418 to 1,460
Plain slag with 0.33 per cent TiO_2	1,360	1,373 to 1,377
Plain slag with 1.33 per cent TiO_2	1,333	1,348 to 1,358
Plain slag with 4 per cent TiO_2	1,285	1,305 to 1,325

very regular and satisfactory, checking those obtained on the Wickwire slag except that all the temperatures are much higher, and even the 0.33 per cent addition of TiO_2 was found to increase the fusibility quite decidedly.

It is interesting to note that both under the reducing conditions of the graphite crucible and in the oxidizing atmosphere of the oil furnace the TiO_2 had a distinctly fluxing action on the slags, so that the action could scarcely be any different under the intermediate conditions existing in the region between metal and slag in an open-hearth steel ladle. The amount of TiO_2 actually acquired by slags in practice from titanium treatment is of course more or less questionable and variable, but in one series of fourteen soft steel heats of which half were treated, the average TiO_2 content of the final slags from the seven treated heats showed an increase of 0.33 per cent over the average for the seven untreated heats, which is exactly the theoretical increase assumed. However, as explained in a paragraph above, it is really the slag included in the metal which it is desired to make more fusible for the sake of cleanness, and the increase in TiO_2 content in these included particles would undoubtedly be higher than in the whole mass of slag, so that the effect of more than 0.33 per cent of TiO_2 is also of practical importance.

Purification of Cotton Linters for the Manufacture of Guncotton and Various Pyroxylin Products

Production of Cotton Linters—Equipment for the Purification of Linters: Digesters, Wash Tanks, Bleach Tanks, Stuff Chests, Surge Tanks, Caustic Tanks, Bleach House, Dry House—The Purification Process—Purification for Pyroxylin Products

By W. STARK

THIS article is being written with the thought that it will perhaps be interesting and informing to those who were not brought into direct contact with the huge munition plants erected in this country beginning with the war in 1914 and reaching their zenith of expansion in the latter part of 1918. The present article has to do only with the conversion of the crude fiber into pure cellulose, from which it passes through the various stages to guncotton, and thence into finished smokeless power, and is a description of the process as applied in the Du Pont plant at Hopewell, Va., and the U. S. Government explosive plants located at Nitro, W. Va., and Nashville, Tenn.

It will be recalled that the United States at the time of the armistice was producing approximately 3,000,000 lb. of smokeless powder a day, and since the conversion factor from cellulose to smokeless powder is approximately 1.5, this meant that 2,000,000 lb. of cellulose had to be produced to be converted into this quantity of powder.

Raw cotton is probably the purest form of cellulose as it occurs in nature, but owing to the high price of this product and its value for the manufacture of cloth, cotton linters and hull fiber were used in its stead. Aside from this fact, ordinary cotton lint has such a long fiber that it packs in going through the various mechanical and chemical processes, and this fact alone precludes its use as a raw material for this purpose.

PRODUCTION OF COTTON LINTERS

Cotton linters is the fuzzy fiber adhering to the cotton seed after it has been ginned. It is removed by a process known as delinting. The fiber of linters is usually about $\frac{1}{8}$ in. long and leaves the outer shell of the cotton seed exposed. The outer shell of the seed, however, contains considerable cellulose, and the necessities of the situation were such during the war, owing to the large demands for any form of cellulose, that mills were erected to shave the outer shell of the seed and produce the material known as hull fiber.

The recovery of cellulose from cotton linters on a 10 per cent moisture basis, after going through the purification process, is about 82 per cent, the remaining 18 per cent being removed in the form of oil and impurities; the recovery of cellulose from hull fiber is about 45 to 50 per cent. In actual practice, therefore, these raw materials were mixed in the proportion of 60 per cent linters and 40 per cent hull fiber as they entered the digester.

When it is remembered that the annual production of cotton linters in this country is 1,250,000 bales of 500 lb. each per year, and the production of hull fiber

during 1917 was only 500,000 bales of the same weight, it will be seen that, with the large quantities of powder being manufactured at the time of the armistice, it would soon have become necessary to use wood to a large extent for the manufacture of cellulose for this purpose. It is to be assumed that Austria and Germany were almost entirely dependent on wood for their source of raw material in this respect.

EQUIPMENT FOR THE PURIFICATION OF LINTERS

The purification building in its essential details consists of eight welded steel digesters, 27 ft. long and 9 ft. in diameter and $\frac{1}{8}$ in. thick in the shell. These digesters are designed to stand a pressure of 150 lb. per sq.in., and at the top there is an opening 30 in. in diameter, which is for the purpose of charging. This opening is closed by the digester cover during the digesting and blowing period. At the bottom center of the digester is a 10-in. valve connecting the digester proper with a 10-in. line which extends to the cyclone tank at the top of the building and enters the tank tangentially. These digesters are set on a steel foundation and are covered with asbestos to conserve the heat during the cooking period. It is into this cyclone tank that the whole charge of cotton and caustic solution is blown after digestion has taken place. At the top of the cyclone tank and extending through the top of the building is a 24-in. vent to release the steam that is the motive force used to raise the charge to the tank from the digester, a distance of approximately 125 ft. The charge flows from the tank by gravity and force, through a 30-in. diameter swinging spiral pipe to the wash tanks. Each cyclone tank serves two digesters, as the blowing of the charge takes only about 5 minutes. The spiral pipe can be swung so as to discharge into either of two wash tanks and after each blow this pipe drips into a drip tank which takes care of any caustic which may flow through it for some time after the main charge. This drip tank has a false perforated bottom and empties into the main spent caustic line.

WASH TANKS

The wash tanks, one for each digester, are made of steel and are 10 ft. in diameter by 16 ft. deep and have a false bottom and a three-arm agitator operated by a gear, which in turn is connected to the drive shaft by a clutch. The whole charge of cotton and caustic flows into the wash tank and the spent caustic passes through a pipe at the bottom of the tank into the main spent caustic line and from there to the drain, or, if the plant has a caustic recovery unit, to the spent caustic storage tanks. There is naturally a

valve in the line connecting the wash tank with the main caustic line. The wash tanks are supplied with water jets, both for cold and hot water, which are located at the top of the tank and are so arranged that the spray covers the entire surface of the charge.

BLEACH TANKS

The bleach tanks are the same size as the wash tanks and are located directly below them. They are made of cypress and other suitable wood, have individually driven three-arm agitators and are connected with the wash tanks by a 16-in. line and a 16-in. quick opening valve through which the washed cotton drops by gravity. These tanks have a perforated false bottom and a pipe connection to the main drainage line. It is desirable to have a compressed air connection entering the bottom of the bleach tanks below the false bottom so that agitation will be facilitated during the bleaching operation.

STUFF CHESTS AND SURGE TANKS

Stuff chests made of wood and the same size as the bleach tanks are located directly below them and on the main floor of the purification building. They are connected with the bleach tanks by a 16-in. line and a corresponding quick opening valve. They have a compressed air connection at the bottom, but no agitators, and at the bottom there is a 6-in. line with a centrifugal pump which lifts the bleached charge to a lead-lined trough, through which the charge flows to the dry house. This trough is set at such a pitch that the charge flows freely through it to the surge tank, which is located on the far side of the dry house from the purification building. As the flow passes through this trough a sufficient amount is taken out at the washer of each drier by automatically operated gates. The charge in the surge tank is agitated constantly and a centrifugal pump circulates the charge from the surge tank to the main trough at a point between the purification house and the dry house. A float in the surge tank operates lights in the purification house, which indicate to the operators when the surge tank is full.

DISSOLVING CAUSTIC

The strong caustic storage and dissolving tanks, two in number for each building, are on the top floor of each building, are made of steel and have false bottoms, and have a circulating system for the more rapid dissolving of the drum caustic and to secure a homogeneous mixture of the caustic solution. Either solid drum caustic is used or caustic solution made from soda and lime. This is pumped from the caustic plant. At Hopewell both were used, as the caustic plant was not sufficiently large to produce the 200,000 lb. of caustic used daily. After the caustic has been thoroughly dissolved, a sample is taken to be titrated, using a standard acid solution and methyl orange as indicator. From this analysis it is determined how many pounds of strong caustic is necessary to make up the caustic charge to be pumped into the digester.

PREPARATION OF WEAK CAUSTIC SOLUTION

Just below each strong caustic tank there is a weigh tank with a capacity of 40,000 lb. of solution. This weigh tank is of course connected with the caustic tank above, and has connections with both the hot

and cold water supply. After the caustic charge has been prepared in the weigh tank, where it is thoroughly agitated, it is referred to as "weak caustic" (usually 2 per cent) and is dropped to the weak caustic storage tanks, six in number, located on the main floor of the purification building. These tanks are the same size as the caustic weigh tanks and have steam coils in them so the caustic can be heated to the proper temperature before entering the digester. From these storage tanks the caustic is pumped to the digesters when ready for use.

BLEACHING SOLUTION

The bleaching solution is prepared in a separate house, which consists of the requisite number of leaching tanks with agitators and storage tanks. Chlorinated lime is used containing about 33 per cent chlorine and a solution is made containing about 2 per cent chlorine. After the solution has become perfectly clear, it is siphoned off to the storage tanks in the bleach house and is then pumped to the bleach measuring tanks in the purification house. There are two of these tanks to each purification house, set on the floor above the bleach tanks so that the solution can flow by gravity to them. They are equipped with a suitable measuring device so that the requisite amount of solution can be readily drawn into the bleach tanks for each charge.

DRYING EQUIPMENT

Each purification house has its corresponding dry house. These consist of six Sargent continuous apron driers. The cotton flows from the trough mentioned above through a chute to the washer of the drier, where the rake moves it constantly to the rolls. It is the movement of this rake which automatically operates the gates of the trough through which the cotton flows to the chute. The rolls press the cotton into flakes about the size of one's hand and deposit them on an apron, which in turn drops them into a picker, which breaks the flakes into a fluffy mass. This mass then passes on to the wire apron of the drier proper and slowly moves forward toward the exit, coming out in the form of a solid sheet. The cotton as it enters the drier contains about 80 per cent moisture and emerges at the end of the drier containing about 1 per cent moisture, from which point it is put into metal or fiber cans, weighed and sent over the telpherage line to the nitrating houses. The drier is heated by steam pipes and the temperature is kept at about 125 deg. C.

THE PURIFICATION PROCESS

The cotton is brought in bales from the crude fiber storage warehouses on an industrial railway and is carried to the charging floor of the purification houses. Here it is weighed, the tare deducted and each bale broken up and dropped into the digester. The tops of the digesters are flush with this floor. The amount of each charge is 5,000 lb. After the cotton is placed, the caustic from the weak caustic storage tanks is pumped in and the covers are adjusted. Steam is then turned into the digester and the pressure raised to 65 lb. per sq.in. and the cooking proceeds for about 5 hours, the hot caustic dissolving the oils, fats, resins and other impurities contained in the cotton. After digestion is completed, steam pressure is raised to 90 lb. per sq.in., the 10-in. valve at the bottom of

the digester is opened and the whole charge blown to the cyclone tank.

In the wash tanks about three successive washings and drainings are sufficient to dispose of the spent caustic contained in the cotton and the charge is then dropped to the bleach tanks, where sufficient bleach solution is added to turn the cellulose perfectly white. Bleaching proceeds for about 3 hours at a temperature of 30 deg. C., and after about 2 hours a sufficient amount of sulphuric acid is added to the charge to drive off any remaining chlorine. The charge is then dropped to the stuff chests ready to be pumped to the dry house when needed.

It will be understood that from the time each charge of cotton enters the wash tanks until it enters the driers it is suspended in about 5,000 gal. of water. Using a mixture of 60 per cent linters and 40 per cent hull fiber, the original charge of 5,000 lb. gives a recovery of about 3,500 lb. of purified cotton, estimated on the basis of 10 per cent moisture.

Steels With Zirconium, Cerium or Boron

AN INVESTIGATION to determine the utility of certain rare-metal alloy steels when used for body armor is shortly to be published by the Bureau of Standards. About 193 heats of steel containing in various combinations the following principal variable elements: carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten, have been studied.

Zirconium, like titanium and aluminum, acts primarily as a scavenger, and when it is not removed as part of the slag remains in the steel, as shown in Fig. 1, in the form of square bright yellow inclusions not directly visible at magnifications much lower than 500. The Bureau of Standards does not consider that these inclusions can be very beneficial and if they are segregated and rolled out into thin plate-like streaks they may be detrimental, especially in armor plate.

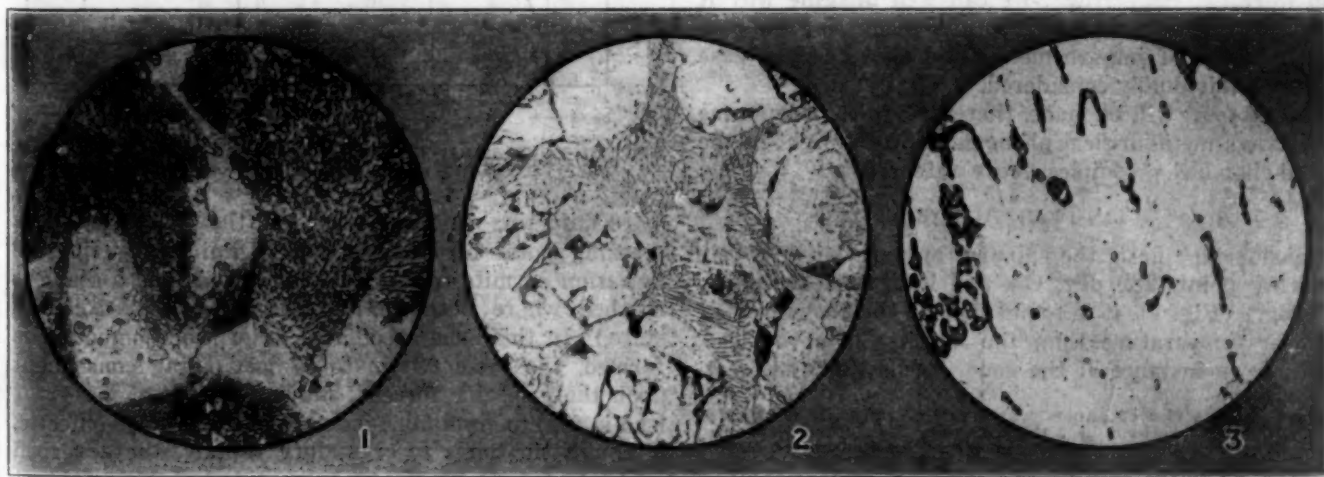
Of the other elements that are regarded as special alloying additions, chromium, tungsten, vanadium and

At the end of one of the driers in each dry house a fan is located connected with a 10-in. galvanized iron pipe line which leads to a bale house. When the production of cotton is greater in the purification area than the nitrating houses can utilize, the excess is baled and stored. It is then used when the nitrating houses are consuming more than the purification area can produce. This discrepancy in balance is caused by bad charges in the purification houses and an undue number of explosions in the nitrating houses.

The purification of cotton for the manufacture of celluloid, fabrikoid, moving picture films and other pyroxylin products follows this same general principle except that in such cases a superior grade of linters is used, a stronger caustic solution is required, the cooking period is extended and a longer period of bleaching is necessary. Also in the manufacture of these pyroxylin products, extreme care must be taken that no dust or other impurities enter the charge at any stage of the process.

molybdenum go into solution and produce a martensitic pattern in the air-cooled specimens. Cerium and uranium act in a similar manner, but also show characteristic inclusions. Copper goes into solution, but a larger amount is required to produce a martensitic pattern in the air-cooled samples than for the others.

Figs. 2 and 3 show the structure of boron steel (Fig. 2, carbon 0.16, boron 0.49, nickel 2.82; Fig. 3, carbon 0.16, boron 0.39 per cent). When the attempt was made to roll this steel under the same conditions used with satisfactory results for steels of similar composition but containing no boron, the metal crumbled and cracked badly in the rolls. Indeed, some ingots were so brittle that they broke under their own weight when carried from the furnace to the rolls. By heating the ingots for a sufficiently long time until considerable coalescence of the eutectic occurred and by reducing the temperature of the ingot somewhat—that is, below the eutectic temperature—no unusual difficulties on working the metal were encountered. As shown in Fig. 3, hot-working breaks up the eutectic and spherical hard particles, similar to iron carbide globules, are formed.



FIGS. 1 TO 3

Fig. 1—Microstructure of steel to which additions of zirconium have been made. $\times 425$. The small light-colored inclusions, square or triangular in outline, are characteristic of steel to which zirconium has been added. They are of a striking lemon-yellow color. Etching reagent, 2 per cent alcoholic solution of nitric acid.

Fig. 2—Section of an ingot of boron steel which broke in the

rolls and could not be worked. The addition of the boron causes the formation of the eutectic shown. Etching reagent, 2 per cent alcoholic solution of nitric acid. $\times 425$.

Fig. 3—Longitudinal section of a rolled plate of boron steel, showing the coalescence of the eutectic which has occurred. Etching reagent, hot alkaline solution of sodium picrate, coloring the carbide a dark brown and sometimes nearly black. $\times 425$.

Colloidal State in Metals and Alloys

III—White Metal and Brass

Solid Solutions and Eutectics, Just Before Solidification, Are Adsorption Compounds—Copper in Alpha Brass Aggregates So Rapidly That Zinc Is Only Partly Adsorbed; Hence Cored Structure—Laminated Eutectic Caused by Skeletal Solidification of Predominating Partner*

BY JEROME ALEXANDER

President, Uniform Adhesive Co., Brooklyn, N. Y.

THE presence in a metal of a second metallic or non-metallic element, whether as an intentional addition or as an accidental impurity, opens a wide range of possibilities, which may be roughly outlined as follows:

1. The second element may form a definite compound with the metal, or it may not.
2. If formed, the chemical compound may be stable at all temperatures or only within a certain temperature range; or there may exist a reversible equilibrium, with a lag on either side of the equilibrium point.
3. The second element or its compound with the metal may be soluble in or miscible with the metal in all proportions; or, as usually the case, there may exist zones of thermal or percentage solubility, dispersion or peptization; or even practical non-miscibility at all temperatures, in which case there usually is a certain degree of segregation.
4. Dissolved or dispersed elements or compounds may materially alter the melting point, viscosity (internal friction), surface tension, vapor pressure, freezing point, conductivity, allotropic equilibrium, and crystallization tendencies of the metal.

The presence of still other additional elements complicates the situation correspondingly; and when to this welter of variable factors we add the further complications of the effects of mechanical treatment and the thermal history of the section of metal under consideration (which involves such factors as speed of chilling, size and shape of the original mass, hot and cold working, tempering), we can well imagine why it is impossible to frame one general law covering the protean behavior of impure metals and alloys. Each case must be individually considered.

The attempt will be made, therefore, to consider some well-known metallurgical phenomena¹ in the light of the colloid-chemical principles above referred to.

TIN-LEAD ALLOYS

Considering first the binary system between tin (melting point, 232 deg. C.) and lead (melting point, 327 deg.) (Fig. 1), it is found that all the alloys melt at a lower temperature than the melting point of lead, which is an instance of the general rule that the freez-

ing point of a solvent is lowered by the presence of a solute. Of all the alloys, that consisting of 63 per cent tin and 37 per cent lead has the lowest melting point, a fact indicated by its Greek-derived name "eutectic." If the metals are mixed in other than eutectic proportion, the excess metal tends to crystallize out alone on cooling, leaving in still fluid condition the maximum possible amount of eutectic, which solidifies later. That the eutectic does not consist of a chemical compound is brought out by the microscope, which reveals its heterogeneity; it is usually laminated and can be brought into relatively coarse dispersion by slow cooling.

But some forces do control the formation of the eutectic, and the mechanism seems to be the following: As the fused alloy approaches solidification, the lead, having the higher melting point, first begins to form molecular groups, crystallogens or tiny crystals. This aggregation of the lead molecules is opposed by the

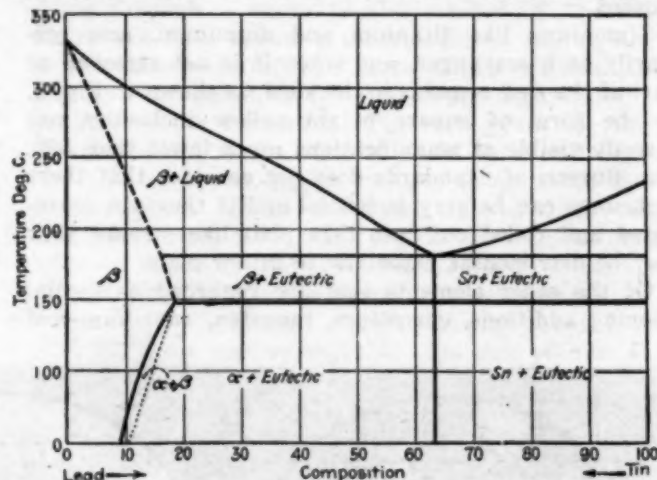


FIG. 1. EQUILIBRIUM DIAGRAM FOR LEAD-TIN ALLOYS. AFTER ROSENHAIN

more fluid tin, which accounts for the lowering of the freezing point of the mixture. Diminishing thermal agitation permits the tin to form groups and a stage is reached where both metals exist largely in colloidal state.² In this zone a colloidal adsorption compound is formed, the ratio 63 tin to 37 lead being consequent upon their specific forces; and any excess of tin or of lead is free to crystallize independently. In the eutectic, although tin tends to crystallize rapidly, the adsorbed lead interferes with its crystallization to such an extent that, if quickly cooled, its structure is extremely fine.

¹The present series of papers was written mainly in the fall of 1919. Reduced to about half their original form, they were read before the Columbus meeting of the American Institute of Mining and Metallurgical Engineers, October, 1920, and will so appear in vol. 64 of its *Proceedings*. They are now given in full, together with some recent additions which are indicated by enclosure within square brackets [].

²Part I, on Molten Metal, appeared in *CHEMICAL & METALLURGICAL ENGINEERING*, Jan. 11, 1922, p. 54; Part II, on Crystallization, in the issue of Jan. 18, 1922, p. 119.

³I have made free use of, and frequently quoted from W. Rosenhain's excellent book, "Introduction to Physical Metallurgy," D. Van Nostrand Co., 1914.

²All metals in solidifying pass through an isocolloidal zone, the narrowness of which is indicated by the sharp peak or cusp in the inverse-rate curve, see Rosenhain, pp. 85-87, and Part I of the present series of articles, *CHEM. & MET. ENG.*, vol. 26, No. 2, p. 54, Jan. 11, 1922.

As with all colloids, this represents a metastable condition, and if the temperature is kept within limits which permit molecular orientation without disruptive thermal agitation, the eutectic undergoes a gradual syneresis analogous to coagulation or demulsification—a further separation into its constituent phases.* The laminated structure, common in eutectics, already represents the coagulation of the pre-existing colloidal dispersion, as will be especially pointed out later in the discussion of pearlite in steel.

EUTECTIC STRUCTURE

Speaking of the tin-lead eutectic, Rosenhain says on p. 133 of his "Introduction to Physical Metallurgy" that "this laminated character, though often beautifully marked, is not to be regarded as an essential feature of these substances. If a specimen of a well-laminated eutectic is heated for a long time at a temperature a few degrees below its melting point, the structure gradually changes, various laminae coalescing to form lumps or globules, and the result is a much coarser granular structure. Such a granular structure may also be obtained if the molten eutectic is very slowly cooled.

"The eutectic alloy is the result, so far as its structure is concerned, of the simultaneous crystallization or freezing of the two component metals. As a rule one of these metals acts as the 'predominant partner,' and its own crystalline form or habit determines the way in which the whole structure is arranged. It has been shown that eutectic alloys, like pure metals, consist of an aggregate of juxtaposed crystals. These crystals are, however, merely skeletons formed of one of the metals—the 'predominant partner'—with the interstices filled in by the other metal. In the case of the lead-tin alloys,

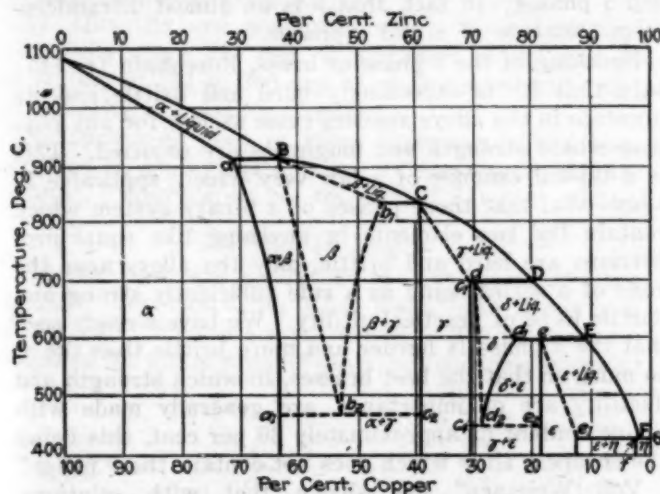


FIG. 2. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS, AFTER GULLIVER

the tin is the predominant metal, and each of the crystals of the eutectic is in reality a radiating structure, known as a 'spherulite,' of tin carrying the lead in its interstices." This is clearly a picture of tin crystallized in the presence of adsorbed lead. Although tin has a lower melting point than lead, its superior crystallization power and speed make it predominant.

Rosenhain also points out[†] that lead-tin alloys containing up to about 16 per cent of tin form a series of solid solutions, which approach their true equilibrium condition very slowly; "it was found that heating at a

temperature of 175 deg. for a period of 6 weeks was required in order to bring the alloys approximately into their final state." This is indicative of the slowness with which the tin in these alloys is peptized or dispersed by the lead. Another observation is that the lead-tin alloys "exhibit an evolution of heat on cooling and a corresponding absorption of heat on heating at a temperature which lies, for alloys containing from 16 to 23 per cent of tin, at 149 deg." Rosenhain's explanation is that this is due to the diminution at that temperature of the capacity of lead to dissolve tin. In any event there is some form of non-stoichiometric molecular aggregation, accompanied by an evolution of heat, quite analogous to what happens when silver hydrosols coagulate. Thus J. A. Prange found[‡] that upon precipitation by ammonium citrate 1 g. of colloidal silver developed from 250.98 to 126.73 calories, depending upon the concentration of the solution; and the further aggregation of the precipitate by H_2SO_4 set free 60 calories more. But here restraining water films were present, and the final product was not yet solid metal.

[The metastability of metals and matter generally has been studied by Prof. Ernst Cohen (Utrecht). At a lecture delivered recently in London[§] he exhibited specimens of explosive antimony, which when scratched, were converted into ordinary antimony with a heat evolution of 20 calories per gram of metal.]

Another point of interest in the lead-tin alloys is found in solder used by plumbers for wiping joints. At about 210 deg., this alloy begins to extrude crystals of lead into the still fluid eutectic cement, rendering it pasty and easy to mold into the desired shape. Here the eutectic acts as a viscous colloid or glue thickened by the addition of clay or other fine insoluble filler.

BEARING METAL AND BRASS

The introduction of the highly crystalline antimony (melting point 630 deg. C.) into the lead-tin alloys results in the early formation of crystals of antimony or of the hard brittle compound $SnSb$, with the result that the ternary alloy is much harder. Type-metal, which varies in composition according to price and service conditions, is usually chilled quickly, which is conducive to hardness and fine structure. White bearing metals, on the other hand, are usually cast in larger masses and chill more slowly; and their composition is chosen to yield, under these circumstances, hard wear-resisting crystals of $SnSb$ imbedded in a colloidal plastic eutectic, which can adapt itself to the bearing's irregularities of shape and pressure.

A consideration of the zinc-copper alloys shows how vitally treatment and composition affect the nature and degree of dispersion of their phases. Brasses containing less than 30 per cent of zinc, whether quickly or slowly chilled, always consists of a solid solution of zinc in copper, known as the pure α body;[¶] but it does not follow from this that the alloys are necessarily homogeneous in all circumstances. If we recall the process of freezing, as already described for a solid solution, we see that in the case of an alloy containing, say, 20 per cent of zinc, the solid which first separates when the alloy begins to freeze will have approximately the composition 13 per cent zinc, 87 per cent copper. If the cooling at this stage is not slow enough to permit

^{*}Recueil des Trav. Chim. des Pays Bas, vol. 9, pp. 121-132 (1890).

[†][See J. Soc. Chem. Ind., vol. 40, p. 1922 R.]

[‡][See also E. Cohen and K. Inonze, "Die Metastabilität unser Metalwelt," Z. phys. Chem., vol. 71, p. 201, (1910).]

[§]Rosenhain; p. 142.

^{*}With tin-lead alloys, this occurs at room temperature.

[†]P. 132; also Rosenhain and Tucker, Phil. Trans. Roy. Soc., vol. 209A, p. 89 (1908).

the attainment of complete equilibrium, the central portion of each crystal—i.e., the portion first formed—will remain to the end considerably richer in copper than the outer or later-formed crystals. Each crystal of metal of such composition will, in the circumstances, consist of a core which is richer in copper, and an outer portion which is poorer in copper, than the average composition of the alloy. A quickly cooled alloy in the cast condition thus shows an apparent duplex structure (Fig. 3), although consisting only of one phase,* for although the layers of solid solution of varying concentration which form these crystals are all of the same α phase, their different concentration renders them susceptible to the attack of etching reagents to different degrees; by most reagents the regions richest in copper are less attacked than those which contain a larger proportion of zinc. Since those portions of the crystals first formed consist of the dendritic branches occurring in the early stages of freezing, the etched pattern of an alloy reveals this dendritic structure, and in some circumstances this may be almost as clearly defined as if the outer regions consisted of a different phase.

"When, however, such an alloy is slowly cooled, or, after rapid initial cooling, is subsequently heated so as to allow the attainment of equilibrium by the slow process of diffusion, the metal becomes entirely homogeneous," the dendritic cores disappear, and we have again the familiar aggregate of homogeneous crystals

such as are seen in all pure metals. It should be noted that the mechanical work and subsequent annealing which occur in the working of brass as usually carried out are also sufficient to render the metal homogeneous in this sense," with the result that wrought brasses containing less than 30 per cent of zinc do not as a rule show any trace of dendritic structure; their structure is in fact very similar to that of pure copper when treated in the same way—i.e., it consists of an aggregate of twinned" crystals whose size depends upon the manner of heating and working."

These facts seem to me to indicate that α brass is really an adsorption compound between copper and zinc, in which the large percentage of copper with the high melting point of 1,083 deg. aggregates so rapidly that even in so-called quickly cooled specimens, the zinc with a melting point of 419 deg. C. is for the most part still so finely dispersed as to be only partly adsorbed by the copper; hence we expect to find a dendritic structure which shows a copper crystallization as modified by

adsorbed zinc, the amount of which increases from the center outward as the copper aggregates and the mother liquor becomes richer in zinc. It is probable that small pieces of α brass drastically quenched from fusion in liquid air would appear homogeneous in the microscope. As Rosenhain points out, the percentage of each metal and its state of aggregation are varying momentarily during cooling, and because of the wide disparity between the melting points of the two metals, homogeneity is favored in this case either by extremely rapid quenching from fusion or else by slow cooling or annealing, which favor more complete dispersion and adsorption of the "segregated" zinc.

With brasses containing 30-37 per cent of zinc, there appears a new hard, brittle, metastable phase, β brass.

Such brasses if quickly cooled are relatively hard and brittle, but if cooled slowly the β phase disappears. With more than 37 per cent of zinc, the β phase is stable at all temperatures down to 470 deg., and the slowly cooled alloys possess the duplex structure (Fig. 4), which is well seen in ordinary Muntz metal (40 per cent of zinc). Carpenter holds that below 470 deg. the β phase decomposes into α and γ phases; in fact, that β is an almost ultramicroscopic mixture of α and γ phases."



FIG. 4. HOT-ROLLED BRASS, ETCHED WITH DILUTE H_2SO_4 AND POTASSIUM DICHROMATE. A yellow β matrix and reddish α figures. After Rawdon. $\times 100$.

Speaking of the γ phase of brass, Rosenhain (p. 145) says that it "is exceedingly hard and brittle and its presence in the alloys renders them useless for any purpose where strength and toughness are required. This is a typical example of a law very widely applicable to alloy—viz., that those phases of a binary system which contain the two elements in anything like equal proportions are hard and brittle, only the alloys near the ends of a series being as a rule sufficiently strong and ductile to be of practical utility. We have already seen that the β phase is harder and more brittle than the α , so much so that the best brasses, in which strength and ductility are of importance, are generally made with a zinc content of approximately 30 per cent, this being the cheapest alloy which does not contain the β phase."

Von Weimarn" has shown that with solutions, medium concentrations are favorable to the development of relatively large crystals, whereas dilute solutions tend to yield colloidal dispersions; and in mixtures of two metals this seems to hold true also. The amorphous or colloidal phase of most metals is stronger at ordinary temperatures; and highly crystalline metal, deficient in amorphous or colloidal phase, is brittle because it tends to split along the lines of crystal cleavage. We should therefore expect brittleness where the component metals of a binary alloy are in about equal proportions, for this concentration hinders the development of colloidal metal and favors larger and more perfect crystals.

(Part IV, dealing with Iron and Steel, will appear in a subsequent issue.)

*The phase rule of Gibbs is postulated on the basis of the homogeneity of the phases involved. Within the colloidal zone, one or more of the phases become heterogeneous, in the sense of the phase rule, which is therefore no longer applicable.

**Obviously Rosenhain means homogeneous to the microscope, for all alloys are essentially heterogeneous.

†Rosenhain, "Introduction to Physical Metallurgy," p. 142.

‡This means colloidal dispersion, favorable to hardness.

§Koll. Zeit., vol. 3, p. 232 (1908); vol. 4, p. 27 (1909).

Low-Temperature Distillation of Amalgams of Non-Coking Coal and Asphaltic Oils*

BY JOSEPH D. DAVIS† AND C. E. COLEMAN‡

DURING some distillation experiments conducted by the Bureau of Mines in co-operation with the Trent Process Corporation¹ it was observed that amalgams² of heavy petroleum oils and finely pulverized coal tended to produce a denser coke than that obtainable from the coal when retorted alone. Even anthracite when retorted with oil yielded a coke. This led the writers to believe that by mixing a low rank coal—sub-bituminous or even lignite—with asphaltic oil, and retorting it, a coke suitable for domestic fuel could be made. Thus was contemplated production of domestic coke and utilization of a low-grade oil in one operation.

In order to decide on the practicability of this process it was necessary to know the value of products obtainable by such a method, as compared with those obtained by separate distillation. A laboratory method was therefore devised, and while it was realized that no small-scale testing apparatus for destructive distillation gives results that are directly applicable to commercial-scale operations, by keeping distillation conditions uniform for comparative tests, results were obtained valuable for purposes of comparison. The plan was to distill mixtures of coal and oil in a laboratory retort, and then distill the constituents separately under the same conditions. The comparative quantities of products yielded were thus directly obtained, and their quality was determined by analysis. The following are the main points investigated:

- (1) Quantity and quality of coke; (2) quantity of oils boiling below 221 deg. C. (gasoline stock) and of oils boiling at 221 to 300 deg. C. (kerosene stock); and (3) quantity and quality of gases.

The apparatus used in these experiments has been described in a previous article. (CHEMICAL & METALLURGICAL ENGINEERING, vol. 25, p. 1132, Dec. 21, 1921.)

MATERIALS USED

The coal used was a mixture of equal parts of Utah Standard lump and Utah King lump, both being non-coking coals. They were pulverized to 200 mesh, and a sample of the mixed product gave the following analysis:

	As Received Basis, Per Cent	Dry Basis, Per Cent
Moisture.....	3.43	
Volatile matter.....	44.92	46.52
Fixed carbon.....	45.62	47.24
Ash.....	6.03	6.24
	100.00	100.00

The oil used was Casmalia crude obtained from Santa Maria, Cal. It contained approximately 9 per cent water, and when dehydrated showed a specific gravity of 1.001 at 15 deg. C. It was a very viscous asphaltic base oil, and left a residue of approximately 15 per cent on distillation to dryness.

About 12 liters of hot water was added to 12 kg. of coal in a 20-gal. stoneware churn. After churning the

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¹Previous papers on the Trent Process will be found in CHEM. & MET. ENG., vol. 25, Aug. 3, 1921, p. 182; Dec. 21, 1921, p. 1131.

²The term "amalgam" is used in its broadest sense to designate an intimate mixture of materials; in this case, approximately 70 parts finely pulverized coal and 30 parts oil.

TABLE I—YIELD OF DISTILLATION PRODUCTS

Yield Expressed as per Cent of Charge			
Charge	Amalgam	Oil	Coal
Max. dis. temp., deg. C.....	600	600	600
Water, per cent.....	14.0	7.0	10.6
Tar:			
Per cent.....	14.2	69.3	11.5
Sp. gr.....	1.038	0.928	1.015
Gas:			
Per cent.....	17.0	4.5	10.1
Sp. gr.....	0.5561	0.6185	0.5816
B.t.u.....	820	966	726
Light oil from gas, per cent.....	8.1	4.0	3.2
Residue, per cent.....	40.1	15.2	60.3
Distillation loss, per cent.....	6.6	0.0	4.3

Yields per Ton of Amalgam			
	Amalgam (670 lb.)	Oil (1,110 lb.)	Coal (1,110 lb.)
Tar, gal.....	32.8	60.9	15.2
Oils boiling 0 to 221 deg. C., gal.....	9.9	9.0	4.1
Oils, boiling 221 to 300 deg. C., gal.....	8.1	17.3	4.1
Gas, cu. ft.....	7,450	668	2,500
Coke, lb.....	802	103	660
Heating value of gas:			
B.t.u. per cu. ft.....	820	966	726
B.t.u. per ton.....	6,109,000	645,288	1,815,000
Sum of Oil and Coal When Distilled Separately			76.1
			13.1
			21.4
			3,168
			763
			777
			2,460,288

mixture for 10 minutes, whereby the coal was thoroughly wetted, 5.1 kg. of oil was added. The mixture was now churned until the coal and oil agglomerated into little balls the size of a pea. The water was drained from the resulting amalgam, which was squeezed to remove inclosed water and allowed to air dry for several days before retorting.

Duplicate distillation runs were made with charges of oil, coal, and a mixture of the two. The charges, approximately 5 kg. in each case, were placed in the cold retort, and gradually heated to a temperature of 600 deg. C. The heating current was then regulated so as to maintain the temperature constant at this point until gas ceased to be evolved, when the test was considered finished. Coal and amalgam were charged directly into the retort, but it was necessary to use a welded sheet-iron container for the oil to prevent it from seeping through the clay baffle into the cold retort bottom and outside the constant temperature zone.

At the end of each test the coke was carefully removed from the retort and weighed, likewise the tars. In order to get the total tar yield, it was found necessary to weigh all parts of the condensing apparatus before and after each experiment.

Table I gives the average yields of distillation products in percentage of material charged, and also in quantities obtained per ton of amalgam. The yields for oil and coal were calculated from the separate distillation tests for quantities sufficient to make 1 ton of amalgam. The sums of yields for oil and coal are therefore comparable with those obtained for the amalgam.

The tar oils were first dehydrated in a 600-c.c. Barrett copper retort, which was heated over night in a Freas electric oven at 105 deg. C., the water and light oils distilling over being caught in a graduated separatory funnel. The water thus collected was measured and drawn off from the supernatant oils, which were returned to the retort. The dry tar was now fractionated from the copper retort, which was heated over a ring gas-burner so that the distillate collected at the rate of two drops per second. The amount of liquid collecting for each 25-deg. interval was noted and the results are given in Table II, together with fractions collected below 221 deg. C. and from 221 to 300 deg. C. These last-mentioned fractions were taken to represent gasoline stock and kerosene stock respectively.

Light oils absorbed in the charcoal scrubber were

TABLE II—TAR FRACTIONATION ANALYSIS

(Per Cent by Volume)												Remarks
	First Drop, Deg. C.,	0-150 per Cent	150-200 per Cent	200-225 per Cent	225-250 per Cent	250-275 per Cent	275-300 per Cent	0-221 per Cent	221-300 per Cent	Residue per Cent	Water per Cent	
Amalgam No. 1.....	125	2.3	6.7	5.0	8.4	12.6	13.8	12.2	35.6	52.2	50.0	240 c.c. sample—245.0 g.
Amalgam No. 2.....	135	...	4.6	5.8	9.2	10.4	14.6	....	....	....	....	240 c.c. sample—247.0 g.
Average.....		2.3	5.6	5.4	8.8	11.5	14.2					
Oil No. 1.....	90	3.2	6.8	4.8	7.2	6.4	16.4	14.8	28.4	56.8	9.3	250 c.c. sample—235.5 g.
Oil No. 2.....	80	4.4	8.0	4.0	6.4	7.6	11.2	....	....	....	....	250 c.c. sample—236.5 g.
Average.....		3.8	7.4	4.4	6.8	7.0	13.8					
Coal No. 1.....	95	2.0	9.3	7.7	8.3	8.0	10.3	18.0	27.0	55.0	52.5	300 c.c. sample—297.0 g.
Coal No. 2.....	110	2.8	8.4	8.4	7.6	9.6	8.0	....	....	....	....	250 c.c. sample—249.5 g.
Average.....		2.4	8.8	8.0	7.9	8.8	9.1					

removed by distillation of the charcoal with superheated steam in a retort heated to 400 deg. C. The oils recovered in this manner from the amalgams and coals were analyzed by fractionation (see Table III), but those from the oil distillation were too small in amount for analysis.

TABLE III—FRACTIONATION OF OIL SCRUBBED FROM GAS

	Amalgam	Coal
Sp. gr.....	0.833	...
First drop, deg. C.....	55	85
From 0 to 75 deg. C., per cent.....	6.5	...
From 75 to 100 deg. C., per cent.....	42.0	22.6
From 100 to 125 deg. C., per cent.....	23.4	32.7
From 125 to 150 deg. C., per cent.....	10.3	26.6
From 150 to 175 deg. C., per cent.....	5.8	...
Residue, per cent.....	7.0	18.1

A number of gas samples were taken at corresponding intervals during each test run and analyzed in the Bureau of Mines gas laboratory. These analyses were averaged, and results are given in Table IV, together

TABLE IV—AVERAGE ANALYSIS OF GASES

	Amalgam	Coal	Oil
Carbon dioxide.....	5.1	8.0	7.3
Unsaturated hydrocarbons.....	8.0	4.0	5.0
Oxygen.....	0.5	0.2	0.2
Hydrogen.....	30.2	28.1	20.6
Carbon monoxide.....	6.1	9.2	0.8
Methane.....	46.6	45.6	51.1
Ethane.....	2.9	4.6	15.0
Nitrogen.....	0.6	0.3	0.0
Calculated heating value, B.t.u. per cu.ft.....	820	726	966

with heating values calculated from the analysis in each case.

DISCUSSION OF RESULTS

The results just described show that the amalgam yields more than twice as much gas as its constituents distilled separately, and less than half as much tar oil. The amalgam gas is richer than the combined gases from coal and oil by 43 B.t.u. per cu.ft., so that the total heating value in the gas from 1 ton of amalgam is 2.5 times that in the combined gases from the coal and oil. There was obtained from the amalgam 18 per cent more solid residue than from its constituents, and, while it was not as dense and firm as by-product coke, it was far superior to the residue obtained from the coal. The latter was only loosely caked together, and could be easily crushed in the hand. The light oil scrubbed from the amalgam gas amounted to 4.4 gal. per ton of charge, and that from the constituents was 0.9 gal. per ton of charge. The oil from the amalgam gas was lighter than that from the coal gas; 42 per cent of the former boiled under 100 deg. C., compared with 22.6 per cent for the latter. There was not sufficient oil obtained from the gas of the oil distillations for analysis.

The main effect of mixing oil and coal previous to

distillation under the conditions prevailing for these tests is to increase greatly the gas yield at the expense of the tar. The increase in gas doubtless comes from the oil. At least a part of the oil in an amalgam must be regarded as adsorbed oil, and under those conditions it would have an abnormally low vapor pressure, which would tend to hold it in contact with the coal at temperatures far above its normal boiling point. This would promote cracking or breaking up into simpler hydrocarbons. In this case, very light liquids and gaseous hydrocarbons were produced.

It is conceivable that the severity of the cracking reactions could be modified by distillation under reduced pressure, so that a high yield of light liquids at the expense of the gas might be obtained. Reduced pressure would certainly increase the yield of liquid products from that part of the oil not adsorbed by the coal.

CONCLUSIONS

Amalgams of a bituminous non-coking coal and a heavy asphaltic oil were distilled to a temperature of 600 deg. C., and the products were collected and examined. The method consisted of charging the material into a cold retort, slowly heating to 600 deg. C., and holding the temperature at this point until gas ceased to be evolved. Following distillation of amalgams, samples of the coal and oil used were distilled separately under the same conditions as those prevailing for the amalgam, the products in each case being collected and examined as before. On comparing the distillation products from the amalgam with the combined products for equivalent quantities of coal and oil distilled separately, the following conclusions were reached: Under the distillation conditions prevailing—

(1) The amalgam yields only about half as much tar oils as its constituents.

(2) A lower yield of gasoline and kerosene stock is obtained for the amalgam—9.9 and 8.1 gal. respectively per ton, as compared with 13.1 gal. and 21.4 gal. from the coal and oil.

(3) The residues obtained from the oil and coal were not coked; whereas that obtained from the amalgam was a coke of fair quality. The residue from the amalgam was 18 per cent greater than the combined residue from coal and oil.

(4) The amalgam yields over twice as much gas as the coal and oil distilled separately and its heating value is 5 per cent higher. The total heating value of gases from one ton of amalgam was 6,109,000 B.t.u., against 2,460,288 B.t.u. for the combined gases from coal and oil.

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Potash Salts of Western Texas

BY GEORGE STEIGER

THE possibility that a workable deposit of potash exists in western Texas is shown by the co-operative work of the United States Geological Survey and the Bureau of Economic Geology and Technology of the University of Texas. Samples of salts brought to the surface by the bailer, during the routine drilling of wells being bored for oil in this region, have been analyzed and if truly representative of beds of any considerable extent and thickness they contain sufficient potash to be of industrial value. Careful consideration, however, must be given the specimens, as these samples were from wells being drilled for oil and not potash, and while not intended to be in any way pessimistic, the object of the first part of this paper is to describe conditions under which samples were collected and to point out some of the pitfalls in the path of those drawing too hasty conclusions from the samples already analyzed.

CONDITIONS OF SAMPLING NOT RECORDED

Oil being the objective and not the soluble salts, no record was kept, so far as known in the Geological Survey, of the quantity of water in the wells or the length of time it may have been in contact with the salts. Neither are any data available concerning casing used, consequently no conclusions could be drawn regarding the possible contamination due to material falling in from higher levels, and only a vague guess could be made as to what extent the potash content of the samples assayed may have been changed by the action of water. Also it is not known whether the entire amount of material supposed to have come from the section in question had been carefully sampled or a grab-sample taken from a single bailerful.

CONCENTRATION BY LOSS OF MORE SOLUBLE SALTS

The samples as received were in fragments approximating in size cracked corn. Had water played the part of dissolving the more soluble salts, the remaining fragments would be expected to show certain characteristics. Fragments of salt only partly dissolved would probably be found with rounded edges. On the other hand, sharp edges on angular fragments might be accounted for by assuming the presence of water in volume sufficiently large to dissolve quickly all salts, including polyhalite, shortly after being torn loose by the drill.

Under the latter condition a sample would represent material through which the drill had passed immediately before bailing. Many of the samples examined contained well-rounded grains of sodium chloride, and, as might be expected, the angular structure of the fragments of polyhalite and anhydrite had been more perfectly preserved.

POTASH PRESENT LARGELY AS POLYHALITE

A number of samples chemically tested showed in every case the potash to be present entirely in the form of polyhalite, and a visual inspection of many more showed this mineral invariably present in the richer salts. With our present knowledge it cannot be positively stated that polyhalite is the only form in which potash is present in these salts, but it certainly occurs largely as this mineral.

Polyhalite, when treated with a quantity of water insufficient to dissolve all the calcium sulphate, leaves a deposit of easily recognizable gypsum.¹ Small quantities of gypsum were found in some of the samples, but the majority of them contained the calcium sulphate in the form of anhydrite.

If these salts had been exposed to the action of water with violent agitation, polyhalite, being rather less soluble than the other commonly occurring salts, could easily have been concentrated. On the other hand, had potash been present in one of its more soluble salts such as sylvite, it would have been dissolved along with the sodium chloride and thus compensate or possibly overbalance the concentration due to polyhalite.

INTENSIVE STUDY REQUIRED

So many unknown factors must be taken into consideration that it is extremely doubtful just what the samples available at the present time represent. It might be that the drill has passed through one or more beds several feet in thickness of potash-rich salts; again, none of them may be more than a few inches in thickness. One thing we do know is that polyhalite has been laid down in the massive form and practically pure, and it seems reasonable to assume that somewhere in the vast salt deposits of this region beds sufficiently thick to be worked economically will be found. In order to locate such beds, if they do exist, core drilling must be resorted to. Meanwhile parties drilling for oil are showing more interest in the possible potash value of their wells and some of the samples recently submitted for assay are accompanied by more carefully taken data. An intensive study made at the wells now drilling will be rewarded certainly with a better knowledge of the extent and thickness of the potash-rich beds and possibly with data upon which industrial development can be based.

Polyhalite, as it occurs in these salts, is light red to gray in color, compact with a fairly granular structure, and practically without taste. It so closely resembles in its properties the anhydrite, which is abundant, that it is not possible to distinguish between the two minerals without resorting to chemical or optical tests.

FACTORS INFLUENCING INTERPRETATION OF ANALYTICAL RESULTS

In the analysis of these salts, a point which deserves special attention is the necessity for stating the ratio of salt to the water used for solution. In the method used by the Geological Survey, 5 g. of the salts is boiled with slightly less than 500 c.c. of water, the solution cooled and made up to 500 c.c. The ratio of 1:100 was arbitrarily taken. If these salts become of industrial importance it may be advisable to adopt a ratio in their analysis more nearly agreeing with that used in their commercial extraction. The necessity of stating the quantity of water used in dissolving these salts for analysis is clearly brought out when the analysis of pure polyhalite is considered. One gram of polyhalite contains 0.452 g. CaSO_4 , 0.199 g. MgSO_4 , 0.289 g. K_2SO_4 , and 0.060 g. of water. While the presence of other salts will slightly change the figures, 100 c.c. of pure water is capable of dissolving at 25 deg C. 0.208 g. of CaSO_4 .

¹A notation made by R. C. Wells in the course of routine assays.

This dissolved CaSO_4 added to the easily soluble MgSO_4 and K_2SO_4 in 1 g. of the mineral will total 0.696 g. or 69.6 per cent of soluble salts. By calculation we find that the 15.6 per cent of K_2O in polyhalite becomes 22.4 per cent of K_2O in the soluble salts. This figure will vary accordingly if a larger or smaller amount of water is used.

An actual analysis made by R. K. Bailey of pure polyhalite separated from salts that were taken from the McDowell well gave the following results: soluble salts 69.9 per cent, K_2O 15.10 per cent, which is equivalent to 21.7 per cent of K_2O in the soluble salts. These figures agree with theory within the limits or error in manipulation.

Analyses of some of the richest salts are given in Table I, the location of the wells being as follows: Bryant well, 9 miles south of Midland, Tex.; Burns

TABLE I—ANALYSES OF SOME OF THE RICHEST SALTS

Depth, Ft.	Soluble Salts, per Cent	K_2O in Sample, per Cent	K_2O in Sol. Salts, per Cent	MgO in Sample, per Cent
Bryant well:				
2,405-2,425	.....	.....	8.94	.....
Burns well:				
1,864-1,865	.....	10.82	.....	.....
Means well:				
935-940	18.7	2.6	13.7	.....
990-995	69.6	11.2	16.1	.....
995-1,000	21.7	3.4	15.5*	.....
1,005-1,010	76.4	4.0	5.3†	.....
1,235-1,240	85.7	6.4	7.5†	.....
1,245-1,250	94.5	4.0	4.1*	.....
1,505-1,510	51.1	3.3	6.5	.....
1,580-1,585	92.4	2.4	2.6	.....
1,625-1,630	90.6	4.5	5.0	.....
1,630-1,635	88.4	4.2	4.8	.....
1,690-1,695	90.9	2.4	2.6	.....
1,695-1,700	99.9	3.1	3.1*	.....
1,740-1,745	76.4	9.0	11.8	.....
1,745-1,750	84.0	7.9	9.4	.....
1,780-1,785	93.7	2.5	2.7	.....
1,820-1,825	57.4	8.2	14.3	.....
1,825-1,830	63.7	8.7	13.7	.....
1,855-1,860	70.6	5.5	8.0*	.....
2,000-2,005	27.3	4.3	15.8	.....
2,005-2,010	27.0	3.4	12.6	.....
2,335-2,340	92.5	3.1	3.3	.....
Pitts well:				
1,600-1,610	62.74	9.03	14.40	4.12
1,610-1,614	66.54	5.60	8.42	2.58
1,645	40.32	4.23	10.50	1.94
1,695-1,700	55.42	6.29	11.35	3.02
1,700-1,704	43.46	2.49	5.74	1.30
1,875	53.60	5.65	10.54	2.72

*R. C. Wells, analyst. †George Steiger, analyst. Remainder, R. K. Bailey, analyst.

well of the La Mesa Oil and Gas Co., 16 miles east of La Mesa, Tex.; Pitts Oil Co.'s well, 8 miles east of Barstow, Tex.; Means well, Loving County, Tex.

MgO found in the six samples from the Pitts well is lightly more than the polyhalite ratio would require to combine for combination with K_2O found in the respective samples.

SELECTED SAMPLE CHECKS WITH POLYHALITE

One sample of rather roughly separated red salt from the Pitts well gave on analysis 13.74 per cent K_2O , while a specimen in a single lump weighing 75 g. contained 11.50 per cent of K_2O . A small sample very carefully separated from salts taken from the Bryant well had the following composition:

	75 g. Lump	Theoretical, Polyhalite
CaO	18.14	18.6
MgO	7.05	6.6
K_2O	15.63	15.6
Na_2O	2.06	...
H_2O	6.13	6.0
R_2O_3	0.35	...
Insoluble	0.22	...
SO_3	Not det.	53.2

Sufficient material was not available for the determination of SO_3 . For comparison the composition of pure polyhalite is given in column 2.

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Export Trade of Switzerland

An interesting summary of Switzerland's foreign trade is given in a recent issue of the *Swiss Exporter*. Up to 1919, Germany was the principal purchaser of Swiss goods, but at that time the various import restrictions of 1920, together with the depreciation of currency rates, relegated her to the fourth rank of markets for Swiss goods. England, which had been third in the list of consumers of Swiss goods up to 1920, now took first place. The increasing difficulties of exporting goods to countries with low rates of exchange makes the exportation of Swiss goods to Great Britain, the Dominions and Colonies an important factor. The total exports to the British Empire amounted in 1920 to 914,000,000 fr., or almost 28 per cent of the total Swiss export trade. This is nearly triple the figure for 1913, while the exports of the British Empire to Switzerland increased more than 3½ times.

The second place among customers of Swiss industries has been occupied by France since 1915, that country taking one-sixth of the total of Swiss exports. The value of machinery exported to France in 1920 reached the sum of 104,500,000 fr. or 35 per cent of the total exports of Swiss machinery.

The goods imported by Switzerland from the United States in 1920 totaled 865,000,000 fr., as compared with exports to this country of one-third that figure.

The exports of coal-tar dyes and synthetic indigo from Switzerland have increased sevenfold since 1913 and total 211,000,000 fr. for 1920. The principal markets during this year were Great Britain with 62,750,000 fr., France 49,200,000 fr., U. S. 16,000,000 fr., Belgium 15,500,000 fr., Italy 10,700,000 fr., South America 8,000,000 fr., and Japan and China 6,500,000 fr. The Swiss coal-tar dye industry goes back to the year 1856 and has its headquarters at Basel. Another important branch of the Swiss chemical industry is that of pharmaceutical products, which is also centered at Basel. The export returns of pharmaceutical products for Switzerland in 1920 totaled 32,000,000 fr., of which 19,000,000 fr. was for vegetable extracts, powders, pastilles, etc., 11,700,000 fr. for alkaloids and 11,100,000 for other remedies, mainly synthetic.

Of recent years there has been great progress in the exports of saccharine from Switzerland and of perfumery, mostly in concentrated form. Recently the manufacture of photochemical preparations has been taken up with considerable success.

Russian Soviet Organizes Production and Sales of Platinum

Commerce Reports of Dec. 26, 1921, reports the organization of a state-controlled "platinum trust" by the the Soviet Government which will have charge of all the platinum prospecting and mining business in Siberia, as well as the platinum smelting and refining works near Petrograd, Moscow and Ekaterinburg. This trust will act as the central sales agency for both foreign and domestic trade, and will thus be in a position to regulate the prices of platinum in the international market.

The total production for 1921 up to August was about 6,000 troy ounces. The annual average production for 5 years prior to 1914 was 172,000 troy ounces. After the beginning of the World War the output of Russia's platinum mines showed a steady decline, production coming to a complete standstill about the middle of 1918.

Fullers Earth Deposit at Olmstead, Ill.

BY CULLEN W. PARMELEE

Professor of Ceramic Engineering, University of Illinois

THE purchase by the Standard Oil Company of Indiana of a considerable tract of land at Caledonia, near Olmstead, Ill., during the past summer has directed attention to the large deposit of fullers earth there.

The discovery of this deposit dates back to about 1912, when H. J. Gardner, then connected with the Kentucky Geological Survey, visited the bluffs on the Illinois side of the Ohio River during the course of his professional studies. Prior to that time Mr. Gardner had met C. C. Ruprecht, who had had considerable experience with fullers earth generally and the Florida deposits in particular. As a sequel of that chance meeting Mr. Gardner's interest in fullers earth had been aroused and noting the peculiar character of the deposit outcropping in the river bluffs, he sent samples to Mr. Ruprecht. Thus, by a fortunate chance, the material was brought to the attention of an expert well qualified to recognize its value and well equipped to devise means for the proper development of the deposit.

Since the raw material proved to be dissimilar to the Florida earth and to have a rather low efficiency, Mr. Ruprecht spent considerable time in devising a suitable process for its improvement. His efforts were finally crowned with success and he and his associates obtained options on the land. In order to demonstrate the value of the earth, the Illinois Fuller Earth Co. was organized, a mill was erected and the prepared earth was marketed.

The mill has been in successful operation for more than a year, and during most of that time it has been running steadily day and night. The Sinclair Refining Co. of Chicago has now taken over the mill and 55 acres of land. In August the Standard Oil Company of Indiana purchased, according to press reports, 155 acres of land, for which \$23,512.50 was paid, and Mr. Ruprecht and his associates received \$100,000 for their patents and rights to processes for the treatment of the earth.

Fullers earth is a variety of clay which has the peculiar property of possessing high absorbent power due to its high colloid content. Formerly it was imported chiefly from England, but a few years ago deposits of suitable material were found in Florida and adjacent parts of Georgia. Since then deposits have been located in other states, so that in 1920 the following were reported by the U. S. Geological Survey in the order

of their rank as the producing states: Florida, Georgia, Texas, Alabama, Nevada, Arkansas, California and Massachusetts. The total quantity of material produced in 1920 was 128,487 tons, valued at \$2,506,189. During the same period 19,235 tons valued at \$221,893 was imported.

WORKING THE DEPOSIT AT OLMSTEAD

The most important use of fullers earth is in the bleaching of mineral, animal and vegetable oils. Other applications are the removal of grease from cloth and in the preparation of soap.

The deposit at Caledonia Landing, as the riverfront at Olmstead is called, belongs to the Midway Formation of the Tertiary System. As already stated, it appears as a bluff about 112 ft. high extending along the shore of the river for about 2 miles. The pit of the Sinclair Refining Co. is situated about 500 ft. back from the river.

The earth is being dug in an open pit (Fig. 1), which covers an area of about 2 acres. The overburden of 10 ft. of sand and loam is loosened by shooting and then removed in wheelbarrows. Below this there is a working face of 34 ft. which is the best quality fullers earth. The earth presents a distinctly jointed structure and is readily dislodged by prying with bars and shooting. Below this face there is 30 ft. of an inferior grade of earth which has only about 80 per cent of the efficiency of the upper portion. The earth thus loosened is loaded into small cars, which are hoisted by cable on an inclined track and dumped into a receiving bin at the factory.

PREPARING THE FULLERS EARTH FOR MARKET

As the raw material comes out of the pit it is in the form of large lumps of a dark brown color having a fair degree of hardness. These are reduced to cubes of 1 in. size by crushing with differential rolls having breaker bars on one roll. These small lumps are fed into a rotary oil-burning direct-flame drier 20 ft. long and 3 ft. in diameter. The maximum temperature reached in this drier is 900 deg. F. The earth passes through this drier in 12 minutes, and during its travel the water content is decreased to 3 to 5 per cent. This is accompanied by a brisk reduction in the size of the lumps due to the popping caused by the rapid removal of the water content. Further crushing is done in a "hammer" mill, where the grain is reduced to pass 10 mesh. The pulverized material is elevated and passed over inclined screens which are electrically vibrated. Three grades are separated: The 16-30 mesh, for the bleaching and filtration of mineral oil; the 30-60 mesh, for the same purpose; the 60-300 mesh, for filtering lard, vegetable oils, soap stock, etc.

The screened dry material is sacked and is then ready for shipment. It is very hygroscopic and takes up about 12 per cent of water during storage and shipping.

The plant has a capacity of about 350 tons per month.

It is reported that the Standard Oil Co. is to erect a plant of about the same capacity as the one described and that another oil company is interested.

Mr. Ruprecht estimates the total amount of fullers earth available as 4,000,000 tons.

The central location of this deposit with reference to the mineral and vegetable oil refineries, its easy accessibility by water and rail and the great quantity of the raw material will make Illinois one of the important producers.



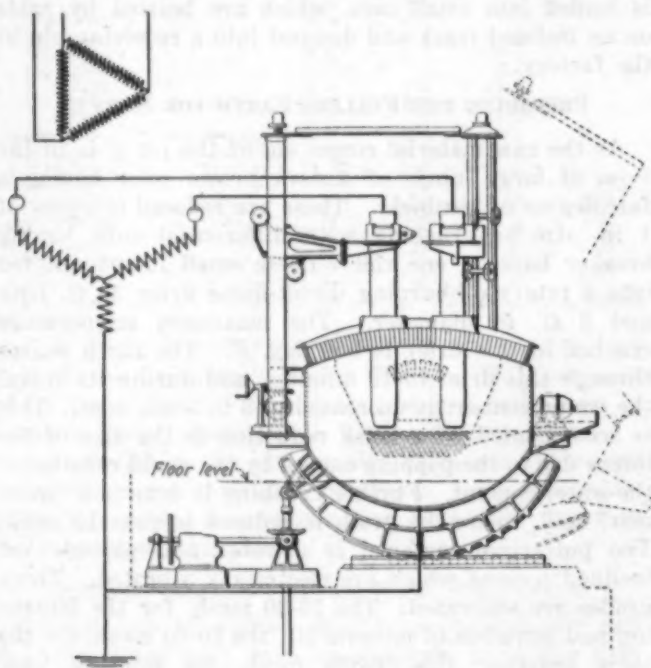
FIG. 1—FULLERS EARTH DEPOSIT AT OLMSTEAD, ILL.

Stability of Conducting Electric Furnace Hearths

BY FRANK HODSON

THE increasing interest that is now being shown in the use of electric furnaces for melting up iron borings and cheap scrap and also in the use of large-capacity electric furnaces for refining hot metal again brings to the fore the advisability of intending furnace users considering the many advantages of furnaces having a properly designed and proved bottom connection.

In the Greaves-Etchells furnace, as will be seen from the illustration, two phases of the three-phase power are taken through top electrodes and the third phase is connected directly to a copper plate lying underneath the lining, giving a definite source of power under the charge. No studs project into the lining and after putting a few inches of special carbon compound over the copper plate, the whole lining is rammed in of standard basic material—dolomite or magnesite, or mixtures of the two mixed with sufficient tar to bind. The lining is purposely made thick and highly resistive at the upper part where it is in contact with the charge. It is here the heat is generated by resistance, not in the copper plate, which always is cool enough to touch. In drying out the lining, the tar, before being burned out, helps to carry



GREAVES-ETCHELLS FURNACE
Dotted lines indicate tilting position

the current through and, once current has been put through, will continue to carry current. If the lining is kept reasonably free from slag or silicon from the roof, the furnaces will start up cold with the bottom functioning normally. In any case, even with a cold furnace, only a very few minutes suffice to get bottom connection. When it is obtained, the advantages are very pronounced. In addition to the top arcs considerable heat is generated in the charge by its resistance to the flow of current—more heat is generated by the resistance of the surface of the hearth and this is immediately absorbed by the charge in contact with the lining.

The charge comes down very evenly without the mechanical stirring or danger of burning the bottom, as when the electrodes of a top-connected furnace bore through the scrap. When molten, the heat generated under the charge keeps it moving slowly upward. This slow circulation from the bottom can be seen and has many times been proved. Temperature of metal at different depths in the bath, analysis of alloy steels at different depths, all prove that slow circulation does exist. In the refining of either iron or steel, this circulation not only carries away and usefully absorbs the intense top heat of the arcs, but also brings all parts of the bath into contact with the refining slags. Sulphur or phosphorus refining and deoxidizing are therefore very rapid and thorough.

The linings are usually constructed with a depth of solid basic refractory from 20 to 30 in., depending on the size of the furnace. As the heat generated at the top of the furnace lining is always absorbed as rapidly as made by the charge, there is no danger of weakening it. The metal comes out clean—a skull on the furnace hearth is practically unknown—no segregation of alloys on the bottom and no thickening up.

Over seventy furnaces with this resistive durable hearth are now in successful operation. A Greaves-Etchells furnace installed in June, 1917, has worked continuously with the production of thousands of casts and is still in operation on the original hearth. In one of the large works here the practice is followed of chipping out about 4 or 5 in. of the top surface of the hearths once a month and re-ramming new material in. This is done more as a metallurgical precaution to insure clean steel, but the real linings of these furnaces have not been changed for years. There is no doubt that a hearth of this type, having very distinct metallurgical and electrical advantages, when intelligently installed and maintained is practically permanent.

Dry-Cell Standards Proposed

FEWER sizes and revised specifications for dry cells will result, it is expected, from the recommendations of the Bureau of Standards on dry cells and dry-cell batteries. These recommendations are those drafted by the conference held at the bureau early in December, when representatives of manufacturers, commercial users and government department users met to plan for simplification and increased efficiency in this industry.

SIZES OF DRY CELLS

The conference considered first the different sizes of dry cells which are now being made. These included seventeen different sizes. As a result of the discussion, six sizes were adopted as standard, one additional size being included provisionally. The members requested the Bureau of Standards to take up the question of tolerances in the dimensions for these cells, and the bureau, therefore, in submitting this report calls attention to the fact that the exact dimensions of the cells and batteries as given in the following tables are subject to revision. The bureau invites criticisms of the dimensions and asks that the manufacturers furnish data for fixing the tolerances. The sizes of dry cells adopted as standard by the conference are shown in Table I.

Several other sizes of cell were considered to be of some importance, but not sufficiently so to be included in the standard list. These are the No. 8 cell $3\frac{1}{2} \times 8$ in. for

TABLE I—SIZES OF DRY CELLS

Designation	Diameter of Zinc Can, Inches	Height of Zinc Can, Inches	Height Over All, Inches	Diameter Over Carton, Inches
No. 6.....	2½	6	6½	2½
No. 4.....	1½	4	4½	1½
Flashlight.....	1½	1½	2	..
Flashlight*.....	1½	2½	2½	..
Flashlight.....	1½	1½	1½	..
Flashlight.....	1½	2½	2½	..
Flashlight.....	1½	2½	3	..

*Provisionally adopted; the use for this cell is decreasing and it probably will not be continued long as a standard size of cell; used in third battery of Table II.

export; a flashlight cell $\frac{3}{8}$ x $1\frac{1}{2}$ in. for small tubular flashlights; the cell 1 x $2\frac{1}{2}$ commonly used in earphone batteries; and a flashlight cell $1\frac{1}{2}$ x $3\frac{1}{2}$ in. which may become an important cell in the future.

FLASHLIGHT BATTERIES

The conference next considered thirty different sizes and kinds of flashlight batteries and adopted eight of

TABLE II—STANDARDIZED SIZES OF FLASHLIGHT BATTERIES

Assembly	No. Cells	Size of Cell		Size of Battery		
		Diameter, In.	Height, In.	Length or Width or Height, In.	Diameter, In.	Depth, In.
Flat.....	2	1½	1½	2½	1½	1½
Flat.....	3	1½	1½	2½	1½	1½
Flat.....	3	1½	2½	2½	1½	1½
Tubular.....	2	1½	2½	3½	2½	1½
Unit cell.....	1	1½	2½	3½	1	..
Tubular.....	2	2½	2½	4½	1½	..
Tubular.....	3	2½	2½	7	1½	..
Box.....	3	1½	2½	3	3½	1½

these as standard sizes. These standard sizes are shown in Table II.

The conference next considered batteries containing fifteen cells for radio use, and standardized two sizes of these batteries as shown in Table III.

TABLE III—BATTERIES FOR RADIO USE

Assembly	No. Cells	Size of Cell		Dimensions of Battery		
		Diam., In.	Height, In.	Length, In.	Width, In.	Height, In.
Rectangular box.....	15	1½	1½	3½	2	2½
Rectangular box.....	15	1½	2½	6½	4	3

The conference also considered batteries assembled from cells of the No. 6 size and selected from about

TABLE IV—ASSEMBLED BATTERIES

Assembly	Voltage	Length, In.	Width, In.	Height, In.
OOOO	6	10½	2½	7½
OO } OO }	6	5½	5½	7½
OOOOO	7½	13½	2½	7½
OOO } OO }	7½	7½	6½	7½
OOO } OOO }	9	7½	5½	7½
OO	3	5½	2½	7½

thirty different sizes and arrangements those in Table IV as standard.

TESTS FOR DRY CELLS AND BATTERIES

The matter of tests for dry cells and batteries was discussed at length and the following conclusions reached: The test which has been commonly referred to as the A. T. & T. test is to be known in the future as the "light intermittent service test."

In the discussion of this test the fact was brought out that the resistance of the telephone circuit is more nearly 50 ohms than 20 ohms and that a 50-ohm test (as well as a 20-ohm test) is in use by the American Telephone & Telegraph Co. It was the opinion of the

conference, however, that the characteristics of the cells are properly shown by the 20-ohm test which has been used in the past and the 20-ohm test should be continued as standard, since the 50-ohm test requires too much time to complete. The ignition test is to be known as the "heavy intermittent service test." The reasons for changing the name by which this test and the telephone test are designated were first that: the names "telephone" and "ignition" imply too limited an application of these tests, and second that the duration of the test is a more important factor than the current intermittently discharged. The heavy service intermittent test was modified by specifying a cut-off voltage rather than the impulse current which has previously been employed to define the end of the test. The cut-off voltage adopted was 0.85 v. per cell. The 10-ohm continuous test for large cells, the 2.75-ohm test for flashlight cells and the flashlight intermittent test were continued as in the past. As a standard test for the radio batteries of fifteen cells each, the conference adopted a continuous discharge through 5,000 ohms to a cut-off voltage of 17 v. for the battery of 1.13 v. per cell.

The conference considered the significance of the short-circuit current test and adopted a motion that this test should not be applied to telephone cells. The bureau was asked to investigate further the significance of the short circuit current test.

WORK IN PROGRESS

The conference instructed the bureau (a) to obtain information from the manufacturers as to tolerances in the dimensions for each size of cell or battery, (b) to prepare specifications for delayed service tests of 3, 6, 9 and 12 months, (c) to revise the specifications which are contained in circular 79 of the Bureau of Standards, and (d) to take up with the earphone manufacturers the possibility of reaching an agreement on standard sizes of batteries for earphones.

In several cases the conference was unable to fix the required performance of certain sizes of cells on test and the matter is to be decided as a result of additional tests to be made on samples submitted to the Bureau of Standards by the manufacturers. Changes in the required performance of flashlight cells and batteries as recommended to the conference by the Bureau of Standards were adopted.

Several times during the discussion mention was made of the possibility of future conferences. No formal action was taken in this matter, but the bureau welcomes the suggestion, and will be glad to do its part in making future revisions and in maintaining the effectiveness of the standardization.

First Aid Treatment for CO Poisoning

The Bureau of Mines has recently issued a report of investigations on the treatment of carbon monoxide poisoning. Although a frequent cause of industrial accidents, there appears to be no uniformly recognized treatment for a person overcome by this gas. The treatment recommended by the bureau is as follows:

1. Administer oxygen as quickly as possible and in as pure a form as is obtainable, preferably from a cylinder of oxygen through an inhalator mask.
2. Remove from atmosphere containing CO.
3. If breathing is feeble, at once start artificial respiration by the prone pressure method.
4. Keep the victim flat, quiet and warm.
5. Afterward give plenty of rest.

Synopsis of Recent Chemical & Metallurgical Literature

Graphitization of White Iron.—In a paper "On Graphitization in Iron-Carbon Alloys" Kotaro Honda and Takejiro Murakami present some new experimental results and a novel theory of the mechanism of graphitization.

For all experiments a white iron of the following composition was used:

	Per Cent		Per Cent
Carbon	3.75	Phosphorus	0.043
Silicon	0.063	Sulphur	0.01
Manganese	0.091		

This material was melted in a small alumina tube heated in a platinum-wound resistance furnace. Temperature measurements were made with a platinum-platinum rhodium thermocouple in a thin silica protecting tube dipped in the molten metal. Analyses made in some of the experiments showed the absorption of silicon by the metal to be less than 0.03 per cent, an amount which the authors consider too small to affect the graphitization. Weight of metal used in each experiment was 20 g., and the degree of graphitization was estimated by microscopic observation, analyses being reported in only a few cases.

PERIOD OF GRAPHITE FORMATION

The stage at which graphite is formed during cooling was determined by quenching experiments. Having determined certain conditions of heating and cooling which would result in graphitization, melts were allowed to cool to various temperatures and were then quenched in water. No graphite was observable after quenching at the eutectic temperature (1,130 deg. C.), a temperature determined by the eutectic arrest in the cooling curve of the specimen. As the quenching temperature fell to 1,100 deg. C. a small amount of graphite was produced, and when the quenching was done below 1,050 deg. C., the amount of graphite was nearly equal to that found after moderately slow cooling to room temperature. It was therefore concluded that graphite does not separate directly from the melt, but forms after solidification and largely between 1,130 to 1,050 deg. C.

Rapid cooling from the molten state produced white iron free from graphite even when the carbon content was raised by addition to almost the composition of cementite. In highly carburized alloys (hypereutectic) cooled somewhat slowly from 1,500 deg. C. two forms of graphite were ob-

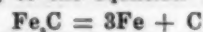
served—large straight plates and small curved flakes, as shown in Fig. 1. If the slow cooling was interrupted by quenching at 1,150 deg. C., the large plates were found, but the small flakes were absent. This result is seen in Fig. 2. The large plates are therefore held to be formed from primary cementite above the eutectic temperature, but the smaller flakes from ledeburite (the austenite-cementite eutectic) below this temperature. Fig. 3 shows the structure of a hypereutectic specimen cast at 1,500 deg. C. in an iron mold. It will be noted that the distribution of the primary cementite is similar to that of the large graphite plates in Fig. 1. The whole structure is on a smaller scale because of the more rapid solidification. A general conclusion that may be drawn regarding the period of graphite formation is that graphitization does not take place unless solid cementite is present.

ANNEALING OF WHITE IRON

It was found that the white pig iron used in this research always graphitized on annealing at temperatures above 1,000 deg. C. The graphite produced at such high annealing temperatures is flaky in form as distinguished from the rounded form found in malleable castings. The authors do not discuss the equilibrium relations of iron, graphite and cementite below the eutectic temperature nor do they report experiments bearing on this phase of the subject.

MECHANISM OF GRAPHITIZATION

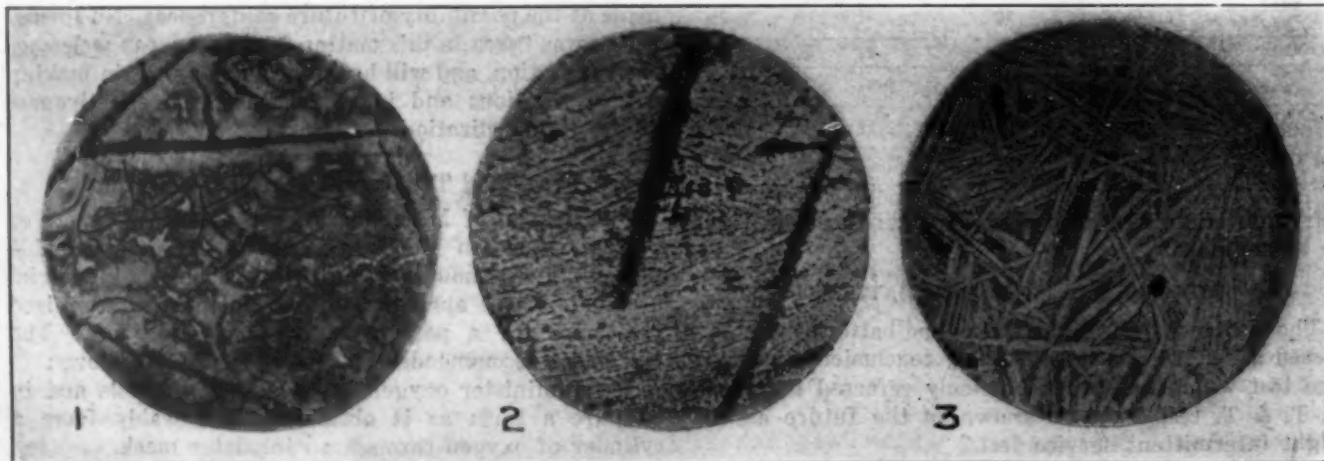
There are, according to the authors, two theories of the mechanism of graphitization: (1) the graphite is considered as a product directly separated from the melt; and (2) it is a secondary product formed by the decomposition of solid cementite, according to the equation



The first theory is untenable in view of the quenching experiments which show that the graphite found in the solid alloy is formed only after solidification.

The authors also reject Howe's explanation, published in his "Metallography of Steel and Cast Iron," that graphite is less soluble in austenite than is cementite, being a more stable phase than the latter, and hence if there is a nucleus of graphite in austenite which is saturated with carbon, graphite is deposited on it, and the solution, becoming unsaturated with carbon, dissolves cementite.

In some of their experiments the authors dipped a graphite rod into the melt and found that the graphite formed during cooling appeared in other regions to a greater degree than at the surface in contact with the graphite rod. They also found that graphitization brought about by annealing did not appear to affect the extent of graphitization on remelting and cooling. From these observations they conclude that the nucleus theory is not probable. A final argument is given as follows:



FIGS. 1 TO 3.

Fig. 1. Straight and curved graphite flakes in high-carbon iron cooled somewhat slowly from 1,500 deg. C. $\times 80$.

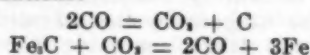
Fig. 2. Suppression of curved flakes by quenching from 1,150 deg. C. $\times 80$.

Fig. 3. High-carbon iron cast at 1,500 deg. C. in an iron mold. $\times 100$.

¹"On Graphitization in Iron-Carbon Alloys," K. Honda and T. Murakami, *Sci. Rep., Tohoku Imperial University*, vol. 10, No. 4, September, 1921, p. 273.

"According to the modern view of crystal structures based on the X-ray analysis, the atoms forming the molecules of a substance are separately arranged in the space-lattice of the crystal. A solid solution of carbon in iron has of course a crystalline structure, and therefore carbon atoms are uniformly distributed among iron atoms in the space-lattice. In the case of the solid solution of cementite in iron, carbon atoms must also be uniformly distributed among iron atoms. Since the crystal system is the same in these two cases and also iron and carbon atoms exert their own molecular forces on each other, the distributions of the atoms will very probably be the same in the two cases. If they were different, we must assume two modifications of austenite; but such modifications are not yet known. Hence there can be no difference between the solid solutions of carbon and cementite in iron and it is rather more correct to say that carbon dissolves in iron as solid solution. The above explanation as given by Prof. Howe is then untenable from the standpoint of the X-ray analysis of crystal structure."

Having thus dismissed the older explanations, the authors advance the hypothesis that graphitization is brought about by a catalytic action of carbon monoxide and dioxide according to these equations:



Thus graphite is produced by the decomposition of carbon monoxide which is regenerated from the carbon dioxide by reduction with Fe_3C . The process continues as long as the supply of cementite and gases holds out.

The evidence upon which this theory is based may be indicated as follows:

1. For a given rate of cooling, the extent of graphitization is less the higher the maximum temperature of the melt and the longer the time of exposure at this temperature. In metal heated to 1,200 deg. C., for example, and cooled at an average rate of about 12 deg. C. per minute, graphitization was about three-fifths complete regardless of the time of exposure of the melt. When the maximum temperature was 1,300 deg. C., the degree of graphitization diminished as the time of exposure increased, and no graphite was observable in specimens exposed at that temperature longer than 10 minutes. With a maximum temperature of 1,400 deg. C., no graphitization took place during cooling irrespective of the time of exposure. It was also found that the graphitization brought about by annealing was less in specimens previously heated at the higher temperatures. These facts are attributed to the decrease of the solubility of gases in the melt with rise of temperature.

2. Graphitization was found to be favored by the introduction of carbon monoxide, carbon dioxide, air or iron oxide into the melt. If the melt was exposed for some time after the addition of the oxygen-containing material, the graphitization became very small. No effect was obtained from passing hydrogen or nitrogen through the melt. These facts are also explained by the gas reaction theory.

3. The effect of air on graphitization was larger than that of carbon monoxide or dioxide. This is attributed to the formation of iron oxide which is supposed to remain in the metal and produce carbon monoxide more effectively than the direct addition of the gas.

4. If the pig iron was melted at 1,200 deg. C. and cooled at about 12 deg. C. per hour, graphitization took place. This treatment did not result in graphitization, however, if the iron was previously melted at 1,400 deg. C. and cast into an iron mold. This is consistent with the supposition that the heating at 1,400 deg. C. drove off the greater part of the carbon monoxide.

5. It was observed that graphite begins to develop from blowholes and cavities, which are regarded as containing the carbon monoxide or dioxide responsible for graphitization. The authors also found no graphite in metal cooled from the molten state in a vacuum unless the cooling was very slow.

6. In some specimens isolated spots were observed in which graphitization was complete. "The gas, which is initially found in their centers, diffuses outward, and owing to its catalytic action, graphitization takes place in spherical forms. The catalytic action gradually diminishes, as a

definite amount of the gas is always distributed in an increasing surface, till the action ceases altogether when the gas density on the surface is reduced to a certain low value, or when the temperature becomes too low for graphitization."

7. The authors found that the ledeburite of hypereutectic iron graphitizes more readily than that of hypoeutectic irons. They consider that this is due to "an ample amount of free gases entered in the melt during the process of carburization by carbon powder."

NATURE OF GRAPHITE FLAKES

The authors disagree with the view of some metallurgists that the flakes are a form of graphite crystal, and hold that they are merely aggregates of fine graphite particles which take their form from the decomposed cementite crystals. They state that continued heating at high temperatures causes a rounding of the sharp corners of the flakes due to the surface tension of the austenite.

MAGNETIC ANALYSIS

The progress of graphitization can be followed by magnetic analysis. As the graphitization increases, the intensity of magnetization due to the cementite will decrease, but the total intensity will increase, owing to the formation of free iron. As the period of annealing increases (and hence the amount of graphite), the intensity of magnetization at room temperature gradually increases and the cementite transformation at 200 deg. C. decreases in magnitude. The ratio of the increase of deflection due to cementite to the total deflection at room temperature is taken as approximately proportional to the quantity of cementite undecomposed.

Some curves are given showing the rate of graphitization on annealing, as estimated by this method.

Dissociation of Ferric Oxide Dissolved in Glass.—In a paper read before the joint meeting of the Glass Division of the American Ceramic Society and the English Society of Glass Technology and published in the November *Journal* of the American Ceramic Society, J. H. Hostetter and H. S. Roberts describe the results of work on the dissociation of ferric oxide dissolved in glass and its relation to the color of iron-bearing glasses. It was shown that above 1,300 deg. C., Fe_2O_3 is dissociated appreciably with evolution of O_2 and the formation of the corresponding quantities of FeO . The same reaction is found to take place in glasses. The following percentages of Fe as FeO based on the total Fe present illustrate the extent of this dissociation in glasses: Diopside glass ($\text{CaSiO}_3\text{MgSiO}_3$), 1,400 deg. C., 20 per cent; 1,500 deg. C. 30 per cent; 1,600 deg. C., 45 per cent. Glass having the composition $0.6\text{K}_2\text{O}-0.4\text{CaO}-2\text{SiO}_2$, 1,310 deg. C., 5.8 per cent; 1,555 deg. C., 10.1 per cent. Glass having the composition $0.3\text{K}_2\text{O}-0.3\text{Na}_2\text{O}-0.4\text{CaO}-2\text{SiO}_2$, 1,020 deg. C. 4.1 per cent. In the two latter glasses a dissociation of 10 per cent produced a bright green color; the glass with a dissociation of 4.1 per cent was yellow. Iron compounds in a glass may therefore be "reduced" by heating to a high temperature under oxidizing conditions. The intensity of the color due to iron is closely related to the composition of the glass, but data on this point are not sufficiently complete to warrant generalization.

Glaze Hardness on White Ware.—George Blumenthal, Jr., described in the November *Journal* of the American Ceramic Society the results of experiments conducted at the U. S. Bureau of Standards on the hardness of glazes for white ware and table porcelain. The enamels show the lowest and the porcelain glazes the greatest hardness, while the white ware glazes occupy an intermediate position. The difference in hardness between the enamels and the white ware glazes is quite marked. There is also a rather well-defined difference between the white ware and porcelain glazes, but not a sharp separation between the lower and higher fired porcelain glazes. Enough evidence has been accumulated to show that increased firing of the same glaze will increase the hardness. It appears also that increase in the alumina content brings about greater hardness.

*K. Honda, *Sci. Rep.* 5 (1916), p. 285; Honda and Murakami, *Sci. Rep.* 6 (1917), p. 235; etc.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Improvement of Patent Office Situation in Sight as House Passes Relief Bill

Despite the opposition of such influential members as Majority Leader Mondell and Chairman Madden of the Appropriations Committee, the House passed without amendment the Patent Office relief bill by the overwhelming vote of 305 to 44. The Senate Committee on Patents expects to consider the bill immediately and it is known that a majority favors reporting the bill to the Senate on the earliest possible date.

The opposition to the bill was based largely on the ground that increases in salary, in some cases amounting to as much as 50 per cent, are being allowed to one group of employees. If the same salary scale were applied to the 300,000 other employees of the government, outside the postal service, it would mean a tremendous increase in the federal expenditure.

The main three features of the bill are that it provides a substantial increase in salaries, particularly to the technical employees of the Patent Office; it provides for an increased personnel, and authorizes an increase in fees sufficient to cover the increased expenditures. Due to the low salary scale, the Patent Office has lost a large percentage of its more experienced examiners and workers with technical experience. During the last sixteen months there has been a turnover involving one-fourth of the total force of 437 examiners. As pointed out by Representative Vestal of Indiana, one of the active supporters of the measure, this has caused the work to be handled much more slowly, until the work of the office is 60,000 applications behind. It also was pointed out that the work in the Patent Office is increasing by leaps and bounds. During the calendar year 1919 the number of patent applications totaled more than 76,000—exceeding by 19,000 the number of applications filed in 1918. The 1918 total was exceeded by 24,000 applications in 1920, and 1921 exceeded 1918 by 30,000 applications. In 1921 there were 87,408 applications for patents, 5,596 applications for designs, and 16,234 applications for trade-marks, making a total of 109,238 applications. This is an increase in work during 4 years of 65 per cent. During those 4 years an increase of 5 per cent in personnel was allowed, but in many instances at a salary scale established in 1854.

Technical societies and other organizations are largely responsible for the pressure which forced the passage of the bill over the protest of House leaders. This support came principally from the National Research Council, American Engineering Council, Manufacturing Chemists Association, American Institute of Electrical Engineers, American Patent Law Association, National Association of Manufacturers, American Society of Civil Engineers, American Society of Mechanical Engineers, National Automobile Chamber of Commerce, Automotive Electrical Association, Electrical Manufacturers Club, American Institute of Mining and Metallurgical Engineers, American Bar Association and the American Chemical Society.

Marvin Appointed Chairman of Tariff Commission

The President has designated Thomas O. Marvin to be chairman of the United States Tariff Commission for the year beginning Jan. 15. He has been a member of the Commission since last March. He succeeds to the chairmanship held until this time by Thomas Walker Page, a Democratic member of the Commission. Mr. Page remains as a member of the body.

At the same time the President designated William S. Culbertson to be vice-chairman of the Commission. It is understood that Mr. Marvin will retire within a few months and that Mr. Culbertson will succeed to the chairmanship. Mr. Culbertson is the member of the Commission who has specialized on chemical matters.

New Sugar Refineries in Operation and Additional Expansion Contemplated

The Coca-Cola Co., Atlanta, Ga., has placed a new sugar refinery in operation in connection with its local plant, for the production of sugar exclusively for company service. The mill is equipped for a daily output of about 200,000 lb., and is of experimental character with view to ascertaining accurately the economies to be effected by individual production, rather than buying the commodity in the market. When success has been demonstrated, it is purposed to establish other such plants to furnish material to the fourteen factories of the company throughout the country.

The new refinery of the American Sugar Refining Co. at Baltimore, Md., is nearing completion and will soon be turned over to the company by the contractors. It is expected that this will take place about March 1, and that production at the plant will be commenced before the close of that month. The initial capacity will approximate 10,000 bbl. a day, or about 3,000,000 lb. Arrangements are now being made by the government for the installation of its department at the plant, to consist of electrical weighing machinery, chemical and other testing apparatus for sampling and revenue work. It is said that the government force to be engaged at the plant will total about seventeen persons, including chemists, inspectors, samplers, electricians and laborers. The equipment to be installed in this department is estimated to cost about \$100,000.

Chemical Fellowships in Twenty Institutions Again Awarded by Du Pont Company

E. I. du Pont de Nemours & Co., have authorized the continuance of Du Pont chemical fellowships in twenty colleges and universities throughout the United States for the scholastic year of 1922-23 of the total value of \$15,000. The fellowships are for post-graduate work and are placed in the institutions which have well-established post-graduate courses. The recipients are selected by the university authorities, the only condition made by the company being that the awards shall go to graduates who devote the major part of their time to the study of chemistry.

The object of the plan is to promote the study of chemistry and to assist deserving students, who have shown especial aptitude for chemistry, to pursue further work. It differs from the usual plan for industrial fellowships in that the company does not insist on the student carrying out an investigation on subjects in which the company is interested, but leaves him free, under the direction of his instructors, to follow whatever line of investigation seems to him most promising.

The institutions which receive these fellowships are Brown University, California Institute of Technology, University of California, University of Chicago, Columbia University, Cornell University, Delaware University, Harvard University, University of Illinois, Johns Hopkins University, Lafayette College, Massachusetts Institute of Technology, University of Michigan, University of Minnesota, Ohio State University, Princeton University, University of Virginia, University of Washington, University of Wisconsin and Yale University.

Leather Company Bans Alien Employees

Effective Jan. 1, the New Castle Leather Co., Wilmington, Del., has adopted a rule that no aliens will be employed at the plant. Employees who are not citizens or who do not take out citizenship papers at once will be dropped from the force. It is said that several months ago the company posted notices requesting that all aliens engaged at the plant become citizens, but the majority at that time declined. In the present instance, the company's decision has brought an influx of applications at the local District Court.

Steel Mills Set the Pace of Increasing Activities in Various Industries

Glass. The John B. Scohy Glass Co., Sistersville, W. Va., is arranging for the resumption of production at its plant, which has been closed down for more than a year past. Employment will be given to about 150 operatives.

Oil. The Denison Oil & Refining Co., Denison, Tex., is arranging for the immediate operation of its new local refinery, rated at a capacity of about 5,000 bbl. per day. The plant was completed several months ago, but production has been deferred until conditions in the industry warranted.

The Waco Refining Co., East Waco, Tex., will commence production at its oil refinery at once, following alterations and improvements in the plant, recently acquired from other interests. William Sacks heads the company.

The Owens Refining Co., Minerva, Tex., is completing the construction of a refinery on local site, with capacity of about 1,500 bbl. a day, and expects to place the plant in operation before Feb. 1.

Rubber. The Intercontinental Rubber Co. has resumed production at its mill at Torreon, Mex., following a shut-down dating from December, 1920.

Copper. The Anaconda Copper Mining Co., Anaconda, Mont., has fired the furnaces at its Washoe smelting plant, as a preliminary heating-up prior to the resumption of operations. The different properties of the company which will start up at an early date include the Leonard, Badger-State, Mountain View and Mountain Consolidated copper mines.

The Boston & Montana Development Co., Butte, Mont., has increased production at its concentrating plant from 50 to 100 tons a day.

The Davis-Daly Copper Co., Butte, Mont., is considering the early resumption of production at its plant, and will send shipments to the Washoe smelting works of the Anaconda Copper Mining Co. About 80 men are now employed for repairs and other miscellaneous operations.

The Utah Copper Co., Bingham, near Salt Lake City, Utah, is planning for the resumption of operations at its properties early in February. About 4,000 men will be employed.

Zinc. The Butte & Superior Mining Co., Butte, Mont., is arranging for the resumption of operations at its local zinc properties.

The Anaconda Copper Mining Co., Great Falls, Mont., has resumed production at its local zinc electrolytic plant.

Iron and Steel. Following the resumption of production at the plant of the Allegheny Steel Co., Brackenridge, Pa., Jan. 16, employment is being given to about 1,000 men.

The Ohio Steel Foundry Co., Lima, Ohio, has resumed production at its plant, following a shutdown since last November. About 500 men will be employed for the present.

The Youngstown Steel & Tube Co., Youngstown, Ohio, has increased operations at its local plant to include twelve of the seventeen furnaces in this district.

The United States Steel Corp. has resumed full operations at its Aetna-Standard plant at Wheeling, W. Va., making three of the company's mills in this district producing in all departments.

The Illinois Steel Co., Chicago, Ill., is maintaining operations at 11 of the blast furnaces at its works.

The Superior Sheet Steel Co., Canton, Ohio, has advanced to full production at its local plant. Since Dec. 1, the works have been running at from 50 to 75 per cent of normal.

The Crane Iron Co., Catasauqua, Pa., is completing the relining of its local blast furnaces, preparatory to the resumption of operations. No date has as yet been announced for blowing in the units.

Metric System Referendum to Be Considered

Whether or not the Chamber of Commerce of the United States will conduct a metric system referendum will be determined at the meeting of the National Council of the Chamber which will be held in Washington, February 8 and 9. The council is made up of one representative each from 1,400 business organizations.

Hearings Before Finance Committee on Cyanide Presage Its Removal From Free List

Unquestionably the controlling sentiment within the Senate Finance Committee favors a duty on cyanides. It is probable that a rate lower than the 33½ per cent duty requested will be prescribed in the bill which will be reported to the Senate next month. It may be predicted, however, with considerable certainty that cyanides will be removed from the free list.

The principal point made before the committee was that the gold-mining industry is in no position to add to the expense of producing its fixed-value product. It was shown that, in the case of the Homestake Mining Co. alone, the proposed duty would add \$25,000 to its annual cost of cyanide.

Senator Smoot of Utah called attention to the fact that only 0.2 lb. of cyanide is used in treating a ton of ore at the Homestake mine. Since the price of cyanide for the past 8 years never has exceeded 25c. a pound to those using it in quantity, he expressed the opinion that it is not going to add greatly to the cost of production of gold, when the cost of the cyanide used would not exceed 5c. per ton of ore treated.

J. C. Hammitt, of the American Cyanamid Co., expressed the opinion that it would be greatly in the interest of the American consumer to permit a continuance of competition between cyanamide producers. The American Cyanamid Co. entered the American market in 1917 and, according to Mr. Hammitt, is now in a position to offer real competition and to break up the character of exploitation which he alleges existed prior to that time.

Circuit Court of Appeals Denies Petition in Minerals Separation Litigation

The Miami Copper Co. made an argument before the United States Circuit Court of Appeals at Philadelphia on Jan. 18 upon its petition for a writ of mandamus to instruct that the master exclude from the accounting proceedings further testimony as to certain processes which have been in use since those found to have been infringing. It was because of its continued use of these same processes that Minerals Separation, Ltd., sought to have Miami Copper Co. found in contempt of court. The Circuit Court of Appeals in an exceedingly detailed opinion sustained the lower court in its refusal to enjoin the Miami Copper Co. The action upon which the court rendered this lengthy opinion was not appealable, and therefore did not actually require from this court more than its statement of that fact, which it made. The Miami company believed, therefore, that this expression of opinion as to the court's views as to these processes could only have been addressed to the master and litigants, as a means of indicating the manner in which they should proceed. The master, apparently, did not accept this view, and so, in the absence of any guiding precedent, refused the petition that he exclude from the accounting further testimony as to these processes. The Circuit Court of Appeals' dismissal of this petition for a writ of mandamus would apparently simply decide that the reply of the defendants to the *prima facie* case which, during the past four years, has been set up before the master, shall, on account of the already voluminous record, be answered before the master, rather than by a new bill.

Rate of Duty on Odoriferous Substances Unfit for Use as Perfume

A Treasury decision has just been issued in which it is pointed out that odoriferous substances, shown to be unfit as such to use as perfume but which are used as bases in the manufacture of perfume, take an import duty of 20 per cent *ad valorem* rather than a duty of 60 per cent *ad valorem*, which applies to perfumery.

Two New Technical Publications

In response to demands from two of its fields, the McGraw-Hill Co., Inc., began, on Jan. 15, the publication of two new papers, *Bus Transportation* and *Electrical Review and Industrial Engineer*. The former will be published in New York and the latter in Chicago.

Senate Approves Resolution Calling for Detailed Alien Property Report

Since a considerable part of the property which came within the purview of the Alien Property Custodian was in the form of chemical patents and holdings in chemical companies, it is expected that the statement called for from that officer by Senator King's recently approved resolution will be of interest to those engaged in chemical industries.

The resolution calls for detailed information as to the names and compensation of all attorneys appointed or employed by the Alien Property Custodian, and of all attorneys, directors, managers and other agents appointed by the Custodian to administer property under his control. It also calls for the names and compensation of all attorneys of corporations, agents or individuals who have been acting as administrators for the Custodian; names of all attorneys who have represented claimants to property under the Custodian's control; names of all attorneys who have represented claimants to whom property has been returned under Section 9 of the trading with the enemy act, and the compensation allowed each out of the trust funds subject to such claims.

In addition the Alien Property Custodian is required by the resolution to furnish a statement and a description of all property which he has sold, together with the names of the purchasers, and the amount involved in the transaction. A statement of all property seized or demanded since the passage of the peace resolution also is requested.

Industrial Applications of Colloidal Chemistry Subject at Connecticut Section A.C.S.

A. W. Thomas, of the Division of Food Chemistry at Columbia University, addressed the January meeting of the Connecticut Valley Section of the A.C.S. in Springfield, Mass. Choosing as his subject "Rationalization of Colloidal Chemistry," Dr. Thomas spoke of some of the new work that is being done in connection with colloidal solutions, mentioning particularly the peptizing effect of ferric chloride and of hydrogen sulphide respectively in the case of colloidal solutions of ferric hydrate and arsenious sulphide. He also described the preparation of collodion membranes of various degrees of permeability and showed that this means of classifying colloids was unreliable unless a complete description of the method of preparing the dialyzing membrane was available. He spoke of the necessity of simplifying the study of colloid chemistry in order that its phenomena might be better understood and become available for use in the industry. In this connection is the instance of a number of reactions that are truly chemical in their nature, although they have been considered by previous workers to be manifestations of adsorption. Of special value to the industry in this connection is the bleaching of sirup solutions by means of bone black. This has been shown recently to be a case of chemical combinations between compounds in bone black and the colored bodies in the sirup and not a case of adsorption.

Engineering Society of Buffalo, N. Y., Established in Club Quarters

The establishment of permanent club quarters in the Iroquois Hotel has greatly stimulated the activities of the Engineering Society of Buffalo. A series of luncheon meetings has been organized, at each of which it is planned to have an address by some local engineer.

At the regular meeting of the society on Jan. 10, E. B. Neil of the Pierce-Arrow Co. spoke on "Progress in Worm-Gear Designing" and Captain George H. Norton of the Buffalo City Planning Commission outlined the activities of the commission in civic improvement.

R. H. McKee, professor of chemical engineering at Columbia University, will address the meeting on Feb. 14 on the subject "Gasoline From Oil Shale."

Evening Course in Metallography

An evening course in metallography, comprising fifteen lectures and fifteen 2-hour laboratory exercises, will be given at the Brooklyn Polytechnic Institute, commencing Feb. 3. The class will be limited to thirty men.

Technical Societies of Detroit Combine Interests in Newly Formed Association

After several years of thought and discussion along similar lines, the movement for the affiliation of the architectural, engineering and other technical societies of Detroit was taken up seriously in June, 1921, by the organization of a temporary council composed of two delegates from each of the several societies interested. The affiliation has become an accomplished fact, taking effect Jan. 1, 1922, by the ratification of the proposed constitution and bylaws, acceptance of membership and election of councilors by the following twelve societies: Detroit Section, American Society of Civil Engineers; Detroit Chapter, American Association of Engineers; Michigan Chapter, American Society of Heating and Ventilating Engineers; Detroit Post, Society of American Military Engineers; Detroit Section, American Society of Mechanical Engineers; Detroit-Ann Arbor Section, American Institute of Electrical Engineers; American Institute of Chemical Engineers; Detroit Engineering Society; American Chemical Society and Detroit Chemists; Michigan Chapter, American Institute of Architects; Detroit Section, Michigan Society of Architects; Detroit Chapter, American Society for Steel Treating.

The permanent council met and organized Dec. 13, 1921, and elected officers for 1922 as follows: Chairman, P. W. Keating; vice-chairman, A. A. Meyer; secretary-treasurer, Walter R. Meier.

The Associated Technical Societies of Detroit will provide one meeting each month which will be under the management of one of the member societies. This member society will provide the speaker on a broad subject of interest to the members of all the technical societies.

Prize Offered by French Society for Gasoline Substitute

Vice-Consul Davis B. Lewis, of Bordeaux, announces in the Jan. 2, 1922, issue of *Commerce Reports*, the organization of a competition with the object of discovering a practical and economical motor fuel with alcohol as the basis of its composition.

At the recent annual meeting of the Agricultural Society at Beziers, in the neighboring Department of Herault, prizes totaling 200,000 fr. were placed at the disposition of the committee, of which amount 100,000 fr. will be awarded to the competitor whose product gives the best results. The competition will be open from January to March, 1922, and the points to be covered will embrace comparative facility of production of the various substances used; increase or decrease of average power obtained compared with petroleum and gasoline; the possibility of blending the proposed product with gasoline for use in motor engines; the percentage of alcohol and other substances of French origin that are used; average horsepower cost per hour; and the originality of the process.

Complete details of the competition may be obtained from the general secretary of the Committee of Organization, 11 Rue d'Assas, Beziers, Herault, France.

Civil Service Examinations

The Civil Service Commission announces open competitive examinations for the following positions. Vacancies exist in the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md.

Chemical technologist, \$3,600 to \$5,000 a year. Associate chemical technologist, \$2,500 to \$3,600 a year. Assistant chemical technologist, \$1,800 to \$2,500 a year.

Applications will be received on Form 2118 until Feb. 14, 1922.

Announcement is also made of competitive examinations on Feb. 8, 9 and 10 and March 22, 23 and 24, 1922, for assistant examiner, Patent Office. Applications should be filed at once on Form 1312.

Washington Chemical Society Elects

The Chemical Society of Washington, D. C., has elected officers for 1922 as follows: R. C. Wells, Geological Survey, president; J. B. Reed, Bureau of Chemistry, secretary; H. W. Houghton, Hygienic Laboratory, treasurer.

Cotton Linters for Paper T.A.P.P.I. Subject

The January meeting of the Connecticut Valley Section of T.A.P.P.I. was addressed by S. E. Seaman of the Stamsocott Co. on the subject of cotton linters. Mr. Seaman described in detail the operation of a modern plant producing paper stock from linters.

New Chemistry Building at University of Missouri

The University of Missouri, Columbia, Mo., has received an appropriation of \$125,000, to be used for the construction of a new two-story chemistry building.

Obituary

JEAN DUBOIS, business manager of the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J., died suddenly at his residence in that city, Jan. 12, following a lingering illness of nearly a year. He was born at Le Locle, Switzerland, on Nov. 24, 1869, and spent his early years in that country. Following a residence of 8 years in South Africa, he came to the United States and engaged in the phosphate business in Florida. Later, he returned to France to superintend the construction of a large chemical plant. In 1911 he again came to the United States and became connected with the Roessler & Hasslacher company, with which he remained until his death. He was a member of the Atlantic Waterways Association and other organizations, and president of the American Terminal and Waterways Association. His wife, a son and daughter, and both parents, survive him.

THOMAS E. DWYER, president and general manager of the Lead Lined Iron Pipe Co., Wakefield, Mass., died Dec. 26, 1921.

JOHN C. PENNIE, of New York City, died on Dec. 23, 1921. By his death the legal profession lost one of its ablest and best known members. Mr. Pennie had not been in good health since the summer of 1921, when he returned from Paris after service of 6 months as a member of the American Commission to Negotiate Peace. However, he was active in the work of his profession up to a few weeks before his death.

Mr. Pennie was born on Aug. 29, 1858, and was graduated from the Albany High School in 1874. He entered Union College at Schenectady and was graduated in June, 1877, with degrees of Civil Engineer and Bachelor of Arts. Then he attended the Albany Law School and received the degree of Bachelor of Law. In the summer of 1878 he went to Europe and pursued his study at the Universities of Breslau and Göttingen. On his return to this country he was admitted to the bar of the State of New York but decided to devote himself to the patent profession and went at once to Washington, D. C., where he entered the Patent Office as an assistant examiner in January, 1881. He remained in the Patent Office until Dec. 3, 1883, serving as assistant examiner of applications relating to metallurgy and later as assistant and acting examiner of interferences. He resigned from the Patent Office in December, 1883, and entered upon the practice of patent law in partnership with John A. Goldsborough, who had been a primary examiner in the Patent Office, and this partnership was continued until the death of Mr. Goldsborough. In 1904, Mr. Pennie moved to New York and continued his practice there in association with D-Cady Herrick and Judge James J. Farren of Albany. During recent years he was the senior partner of the firm of Pennie, Davis, Marvin & Edmonds.

The high position which Mr. Pennie had attained among the members of the bar specializing in patent law led to his selection as the adviser of the American Peace Commission on patent matters, and he spent the first 6 months of 1919 in Paris advising with the representatives of other countries on the provisions of the peace treaty relating to patents. In appreciation of his work as a member of the commission, King Albert of Belgium commissioned him a Commander of the Order of the Crown.

After Mr. Pennie's return to the United States a representative of the King presented to him a medal and certificate of his appointment.

Throughout his professional life Mr. Pennie made a host of friends, all of whom held him in highest esteem for his estimable qualities of heart and mind. His strong characteristics were a broad catholicity of spirit, a genial kindness toward all men, and a sterling integrity, coupled with a broad faith in and a comprehensive charity for his fellow men. He was a man of rare mental attainments, remarkably sound judgment, and an indefatigable worker in the many fields into which he directed his wonderfully fertile intellect. Even in the busiest intervals of his most exacting profession, he was ever ready to give of his time, knowledge and experience to help anyone less fortunately situated, either professionally or socially.

Personal

FRED P. BAKER, for the past year and a half assistant director of the Boston station of the School of Chemical Engineering Practice of the Massachusetts Institute of Technology, has resigned to accept a position as chemical engineer with the Procter & Gamble Co., Cincinnati, Ohio.

Dr. FRANK R. ELDRED, for 20 years director of the scientific division of Eli Lilly & Co., of Indianapolis, has resigned to engage in consulting work under the firm name of Eldred & Aitkinson. Mr. Aitkinson was formerly chief chemist of the American Hominy Co.

F. M. FEIKER, who went to Washington 8 months ago as assistant to Secretary of Commerce Hoover, and on leave of absence from the McGraw-Hill Co., is now back in his old position as editorial director. He has not, however, completely severed his relations with the Secretary or the department, but has been appointed a special agent of the Bureau of Foreign and Domestic Commerce, to continue in a consulting capacity the work he has been rendering. Under the direction of Mr. Feiker and Dr. Julius Klein, Director of the Bureau of Foreign and Domestic Commerce, the industrial and business contracts of that bureau have been enlarged, business relations with trade association committees have been established and the so-called Commodity Divisions of the bureau created. During Mr. Feiker's stay with the department, *Commerce Reports*, the government's official foreign trade paper, has been changed from a daily to a weekly publication and the monthly "Survey of Current Business" was brought into existence. Mr. Feiker's services extended to the Bureau of Standards, the Bureau of the Census and other parts of the department. He served as editorial adviser on the department's board of editors.

LLOYD A. HALL has severed his connection as manager of Vodin, Inc., to establish a business on his own account under the name of the Chicago Chemical Products Co., Chicago, Ill.

ABEL HANSEN, Perth Amboy, N. J., head of the Fords Porcelain Works of that city, has been re-elected president of the Fords National Bank, Fords, near Perth Amboy.

GEORGE A. MACINTOSH, secretary of the Butterworth-Judson Corporation, New York, has been elected a director of the company to succeed M. F. Chase.

CHARLES A. MAY, head of the Maddock Lamberton Works, Trenton, N. J., has been elected a director of the local Mechanics National Bank.

WILLIAM D. MAINWARING, for the past 11 years connected with the Detroit plant of the Railway Steel Spring Co. as chemist and metallurgical engineer, has opened a consulting business at 866 Rockefeller Bldg., Cleveland, Ohio, as a production engineer. Mr. Mainwaring was formerly connected with the open-hearth department of the Pencoyd plant of the American Bridge Co., during the installation of the continuous process of the manufacture of steel.

E. J. VOSS, of the Graham Brothers Soap Co., Chicago, Ill., has been elected president of the local Perfumery, Soap and Extract Association.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

When Does a Currency Collapse?

How much can a currency depreciate before it becomes worthless? To what low level can the mark sink before Germany becomes bankrupt? These questions and the circumstances from which they have arisen have caused us to revise many of our fundamental notions of political economy and national finance.

Take, for example, the Polish mark, which has a nominal gold value of 23.82 cents in our money, and is now worth but 0.03% of a cent. This is a depreciation of 99.9 per cent from par. An even more striking case is that of the Russian ruble, formerly worth 51.45 cents, but with a present value so small that it is no longer handled in the old denominations. Notes of 50,000 and 100,000 rubles are in common use.

The Austrian crown, with a nominal gold equivalent of about 20 cents, can be bought for 0.03% cent, and the Hungarian crown of the same par value is worth 0.12% cents. That such depreciation is not limited to the nations of central and western Europe is attested by the fact that the escudo of Portugal can be purchased at a discount of 93.5 per cent and the Chilean peso at a discount of 71.8 per cent. It is natural that the question should be asked: How long will a people cling to a currency which is tottering on the very verge of extinction?

One phase of the situation which is not always appreciated is the very great effect caused by even the slightest fluctuation in the values of these depreciated units. When the mark, for example, fell from 1½ cents in June to about ½ of a cent in December, 1921, there must necessarily have been a tremendous reduction in its purchasing power. Since Germany is importing much of her foodstuffs and raw materials and paying for them at high rates of exchange, commodity prices (except in cases of government subsidy) have risen with the decline in the value of the mark. Wage advances, on the other hand, are comparatively slow, and in the meantime strikes and other evidences of internal industrial disorganization are a natural consequence. The recent report of the U. S. Tariff Commission includes some pertinent comment on the relation between wages and prices:

A comparison of wages in the United States, England, France and Germany shows that they are less adjusted to a gold basis than are prices. In May, 1921, the standard wage in Germany for factory workers was, roughly, 10 cents per hour in gold as compared with 20 cents to 25 cents in France, 30 to 40 cents in England, and 50 to 75 cents in the United States.

There is a discrepancy of slightly more than 2 to 1 between the internal purchasing power of the mark and its gold value in foreign exchange, according to the commission. This is obviously to the very great advantage of the

RATES OF EXCHANGE OF SOME OF THE PRINCIPAL FOREIGN CURRENCIES AT NEW YORK

Par of Exchange Cents	Foreign Currencies	Federal Reserve Exchange Rates Certified Jan. 18, 1922 Cents	Per Cent Depreciation from Par
486.65	British pound.....	422.35	13.21
19.3	French franc.....	8.15	57.71
23.82	German mark.....	0.5147	97.8
19.3	Belgian franc.....	7.80	59.6
23.82	Polish mark.....	0.0344	99.9
19.3	Greek drachma.....	4.37	77.5
19.3	Italian lire.....	4.35	77.6
19.3	Spanish peseta.....	14.96	22.5
19.3	Swiss franc.....	19.42	.....
20.26	Austrian crown.....	0.0316	99.9
20.26	Czechoslovakian crown.....	1.6803	91.7
20.26	Hungarian crown.....	0.1244	99.3
26.8	Swedish krona.....	24.88	7.5
40.2	Netherlands florin.....	36.71	8.7
108.0	Portuguese escudo.....	7.42	93.5
51.45	Russian ruble.....	0.1125	99.7
32.44	Brazilian milreis.....	12.51	61.5
36.50	Chilean peso.....	9.75	71.8
100	Canadian dollar.....	94.75	5.3

German exporter who sells in dollars but pays for his labor and materials with marks.

Brief Market Notes About Chemicals and Related Commodities

Naval Stores. The estimate of the Department of Agriculture for the production of gum turpentine during the 1921-22 season is 427,000 casks of 50 gal. each. The estimate for gum rosin is 1,320,000 bbl. of 280 lb. The corresponding production during the 1920-21 season was 488,690 casks and 1,577,390 bbl.

Paradichlorobenzene. A bulletin recently issued by the Bureau of Entomology of the Department of Agriculture describes the use of paradichlorobenzene as a means of preventing or lessening the ravages caused by the peach borer. Experiments begun in 1915 and carried on largely under the direction of E. B. Blakeslee and A. L. Quaintance of the bureau showed "paradichlor" to be particularly effective in preventing the peach borer from attacking and seriously injuring the trees. It is applied in the fall of the year around the base of the tree and about 2 in. from the trunk. One pound is said to be sufficient for 16 trees.

A large-scale demand for paradichlorobenzene would be welcomed by chemical manufacturers.

Chemical Glassware. Exports of chemical glassware for the 11 months ended Nov. 30, 1921, were valued at \$215,294. During the month of November the exports, which amounted to \$12,692, were shipped to twenty-one different countries.

In amount this may seem but a trivial item, but it is extremely significant that the United States, formerly entirely dependent on a foreign source of supply for all chemical and scientific glassware, has now developed an industry which is capable of competing with the German and Austrian manufacturers not only in the United States but in many of the principal foreign markets of the world.

Wholesale Prices in December

Reference was made in these columns last week to the price indexes of the Bureau of Labor Statistics, the most recent figures being those for the month of November. On Jan. 19 the bureau announced that the index number for all commodities stood at 149 for December, the same as in the previous month. Farm products and foods again showed a downward tendency. Chemicals and drugs fell off slightly, the index number changing from 162 to 161. Metals remained constant at 119.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	143.50
Last week	143.75
January, 1921	181
January, 1920	242
April, 1918	286

This index number, which is based on the wholesale prices in the New York market for a group of twenty-five representative chemicals and related commodities, continued its decline during the past week. Slightly lower prices for caustic soda, formaldehyde, salt cake and citric acid were principally responsible for the change in this week's index number.

The New York Market

NEW YORK, Jan. 23, 1922.

The consuming industries have shown some interest in the chemical market during the past week, although the actual volume of business has been rather small. Large-lot buying was exceptional and most of the consumers were contracting only for actual requirements. Prices along the entire list have remained quite steady. The interest in prussiate of soda has continued and high prices have been maintained, with very little offered either for spot or contract purchases. Prussiate of potash, however, has been in increasing demand, both for the red and yellow. Orders have been in the market for the former as high as 32c. per lb., but holders have advanced prices to 33@34c. per lb. The yellow has sold at 25c. per lb., ex-store. The market for arsenic continued very strong. Leading factors are of the opinion that large quantities will be extremely difficult to locate in the very near future, because of the scant importations. Domestic producers are not anxious to supply the trade at present prices, but are waiting for a substantial rise in the market. Their quotations range from 7@7½c. per lb., while odd resale lots sold as high as 8c. per lb. on the spot.

Producers of chlorate of soda have reduced prices to 7c. per lb. Imported material can be bought as low as 6½c. per lb. Makers of chlorate of potash are still quoting 12c. per lb. on the powdered, but it is commonly known that shading on firm business is being done by leading dealers. Importers are generally holding their material at fairly high prices to make purchases under 6@6½c. per lb. on spot. Shipment material from abroad is offered at 5½c. per lb. Manufacturers of barium chloride quote \$50 per ton for quantity shipments. Importers are having difficulty in competing with the domestic quotations at present. Additional sales of solid caustic soda for export were reported at \$3.60 per 100 lb. Small-lot sales have gone through at 3½c. per lb. Producers quote the market for contract at \$2.60 per 100 lb., basis 60 per cent, f.o.b. works. Small-lot trading in light soda ash, single bags, was reported at \$1.90@1.95 per 100 lb. on spot. Dealers stated that carload quantities have been moved at \$1.75 per 100 lb. Offerings were rather scarce and producers stated that contracts were being booked at the works at \$1.35 per 100 lb., basis 48 per cent. Makers of bichromate of soda quote 7½@8c. per lb., with only a moderate demand from consumers. Bicarbonate of soda is quoted at 2c. per lb. f.o.b. works for barrels and 2½c. for kegs. Offerings on spot in carlots have been heard at \$2.15 per 100 lb., and smaller quantities at \$2.30. The buying movement is rather quiet at present, although a steady call on contract shipments is reported. The tartaric acid market has shown signs of weakness and prices at the close were decidedly lower for imported material. The demand has not been active and considerable competition has developed among holders. Final quotations were 24@25c. per lb. for crystals and 25@26c. per lb. for the powdered. Domestic prices remained quotably unchanged.

COAL-TAR PRODUCTS

The coal-tar products market has undergone some revision in prices since the beginning of the year. Evidence of keen competition is reflected in the course of many prices. Consumers are not buying freely, because the market is flexible enough to suggest that future prices may be more attractive. Benzene continues to command considerable attention and refiners are holding prices firm at the recent advance. The c.p. grade is quoted at 29@35c. per gal. in tank cars and drums. Naphthalene is another item receiving attention and prices in refiners' hands are held steady at 7½@8½c. per lb. for the flake. Inquiries are resulting in placing a moderate amount of business for the coming season. A steady absorption of spot supplies of phenol has placed this commodity in a stronger position. A price of 12c. per lb. was considered a very attractive figure for the U.S.P., while the range extended all the way up to 16c. A fair inquiry for domestic consumption was recorded.

The St. Louis Market

ST. LOUIS, Mo., Jan. 20, 1921.

There has been a noticeable improvement in the chemical line since Jan. 1 in this section, although reports from other quarters do not disclose any real change. It is not expected that there will be any sudden expansion in business, but that there will be a steady increase from week to week.

ALKALIS

Caustic soda remains firm at the same price as last week, \$3.40 per 100 lb. for 76 per cent solid in drums in carlots at point of production, single drums at \$4.25 per 100 lb. f.o.b. St. Louis. The 76 per cent flake is quoted at \$4 per 100 lb. at point of production in carlots, while single drums are held at \$4.87½ f.o.b. St. Louis. Contracts are being executed at this price with protection against decline. Bicarbonate of soda is moving slowly at \$2.90 per 100 lb. in single barrels, \$2.65 per 100 lb. in 10-bbl. lots. Salsoda at buyer's command, at \$2 per 100 lb. in single barrels.

GENERAL AND SPECIAL CHEMICALS

Acid citric fails to show any increase. Gallic and pyrogallie acids are in better demand. Phosphoric acid is moving more freely. While the demand for tartaric acid at the close of last year was practically nil, the demand since the beginning of this year has been very gratifying. Ammonium sulphate is moving fairly well, but the demand is not as large as expected. A larger volume of business is being passed on barium sulphate; furthermore, the inquiries for blanc fixe are increasing. Cream of tartar continues to move in a routine way. The market on glycerine is very firm at 16c. in drums, and a further raise of ½c. is expected. Demand is strong. Sulphur is moving slowly, and the price is getting weaker.

VEGETABLE OILS AND NAVAL STORES

Turpentine reached the highest price for some time when it sold for 97c. in single barrels last week. It can now be obtained for 93c. The demand is strong. Linseed oil is keeping step with the flaxseed market, and is now being held at 75c., basis raw oil in cooperage. Contracts for future delivery after May 1 are being taken at the prevailing price of 75c. Castor oil is entirely in the producers' hands and is being held firmly at 13c. per lb.

PAINT MATERIALS

Lithopone is being held at 6c. for carlots and 6½c. in less than carlots by the producers in this locality. Only one of the three plants in this district is in operation. Imported goods are a disturbing factor. Barytes is still holding at \$23 in ton lots. This has been shaded on carlot inquiries. Demand is only fair. Whiting of all grades and all prices is being offered in this market at \$11 per ton in carlots for air floated, with as high as \$15 for water ground and water floated.

The Iron and Steel Market

PITTSBURGH, Jan. 20, 1922.

Demand for steel products in the past week has been of decidedly moderate proportions. The volume of business is perhaps heavier now than in the first two weeks of January, but it can scarcely be regarded as showing as much improvement as would be expected, now that the holidays and the annual inventory date are left behind. There is not a reversion to the conditions of October and November, when buying was sufficient to support steel production at the rate of fully 23,000,000 tons a year. This was not a high rate, generally speaking, but it was the highest rate shown since February. The average rate of production during December was 20,000,000 tons a year, the rate being above this at the beginning of the month and lower at the close. It is doubtful whether the rate now is as high as 20,000,000 tons. This, by the way, is about 38 per cent of the entire capacity in existence and somewhat under 50 per cent of the capacity of the strongest companies, those with the best facilities for economical production.

The demand for steel that has come out in the past week would scarcely be a safe criterion as to what is to be expected in the next few weeks or months, the period since the

first of the year being too short for guidance, but there is some contributory evidence in the attitude of the mills. This attitude has been very aggressive. All orders of any size are strenuously contested for by every available means, including price concessions.

Regular prices are no lower in the case of any important finished steel product, there having indeed been no change in this respect for a month, or since the formal reduction in wire prices by the leading interest. The change in the week is simply that prices below the regular level are being made on somewhat smaller tonnages, and thus the average of the entire tonnage sold is slightly reduced. The majority of orders placed are at full prices. This can easily be the case without its meaning much as to market stability, for the reason that the majority of buyers are ordering in single carloads. Regular prices are as follows: Bars, shapes and plates, 1.50c.; hoops, 2c.; plain wire, 2.25c.; wire nails, \$2.50; standard steel pipe, 71 per cent basing discount; blue annealed sheets, 2.25c.; black sheets, 3c.; galvanized sheets, 4c.; tin plate, \$4.75.

Manufactured steel products continue to show a general declining tendency, but in this they are merely following the rolled steel materials from which they are made. Generally speaking, the manufactured products have been rather tardy in their response. In most cases these materials are at higher percentages above their pre-war levels than are rolled steel products. The base price of chain, on 1-in. proof coil, has been reduced from 5.90c. to 5.50c., and differentials have been so revised that greater reductions have been made on some descriptions of chain, such as BB. Railroad spikes are down from 2.25c. to 2.15c. or 2.10c., depending on size of order, and small spikes, boat and barge spikes are down to 2.35c. or 2.40c. even on quite moderate sized orders. Rivets remain at 2.25c. for structural and 2.35c. for boiler, but are far from firm at these figures. Cold-finished steel bars are quite irregular and present no well-defined market price.

PIG IRON AND COKE

Pig iron continues decidedly quiet and prices are unchanged, perhaps partly because there has been no inquiry of sufficient importance to develop competition. The market is quotable at \$19.50 for bessemer, \$18.25 for basic and \$19.50 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96.

These prices are all below the current cost of production, basing cost on present market prices for Connellsville coke and last season's prices on Lake Superior ore. Basic iron is particularly low. Its decline seems to have been due to the selling of iron by steel works, not necessarily because of steel works having a lower cost than merchant furnaces, but in part at least because the steel works had unfortunately accumulated the iron and it is more economical for them to make fresh molten iron than to melt the stock iron. Some of the steel works, however, have byproduct coke ovens and a lower production cost, other things being equal, than merchant furnaces that buy their coke.

Connellsville coke for spot shipment, reported stiffer a week ago, has softened again, as odd lots can be picked up at \$2.75. Probably not much could be found at \$2.75, but there is at least as much as the market is disposed to absorb. The blast furnaces rarely buy any spot coke nowadays, since deliveries on contract are ample, and the buying is restricted to the miscellaneous consumers, brick yards, bakeries, etc., whose purchases are always relatively small. Contract furnace coke shows no developments, the business for the current quarter being all done, with the last contract reported at \$3.10, the lowest price done in the contract movement.

Spot foundry coke is easier, and is quotable at \$3.75@ \$4.25, against a range of \$3.75@ \$4.50 formerly quoted. The \$4.50 coke is practically out of the market. There have been offerings at \$3.50 in the past week, but they scarcely justify inclusion of the price in the market range. One set of offerings is of a coke that is not selected according to standard practice, while other offerings were by a producing interest whose ovens are idle, the object apparently being to accumulate a tonnage that could be offered in a lump to producers in hopes of getting a special price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.40 - \$0.45
Acetone.....lb.	\$0.12 - \$0.12	13 - 13
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.60	2.65 - 3.00
Acetic, 56 per cent.....100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99 per cent, carboys, 100 lbs.	9.50 - 9.75	10.00 - 10.50
Boric, crystals.....lb.	12 - 12	13 - 13
Boric, powder.....lb.	12 - 13	13 - 14
Citric.....lb.		43 - 44
Hydrofluoric.....100 lb.	1.50 - 1.60	1.65 - 2.00
Hydrofluoric, 52 per cent.....lb.	12 - 12	13 - 13
Lactic, 44 per cent tech.....lb.	0.9 - 1.0	1.0 - 1.2
Lactic, 22 per cent tech.....lb.	0.4 - 0.4	0.4 - 0.5
Molybdic, c.p.....lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	0.6 - 0.6	0.6 - 0.7
Nitric, 42 deg.....lb.	0.6 - 0.7	0.7 - 0.7
Oxalic, crystals.....lb.	14 - 14	14 - 15
Phosphoric, 50 per cent solution.....lb.	10 - 10	10 - 11
Picric.....lb.	20 - 25	27 - 35
Pyrogallol, resublimed.....lb.		1.65 - 1.75
Sulphuric, 60 deg., tank cars.....ton		11.00 - 12.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	16.50 - 17.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. F.....lb.		65 - 75
Tannic (tech.).....lb.	45 - 50	51 - 55
Tartaric, imported crystals.....lb.		24 - 25
Tartaric acid, imported, powdered.....lb.		25 - 26
Tartaric acid, domestic.....lb.		27 - 32
Tungstic, per lb. of WO.....lb.		1.00 - 1.10
Alcohol, ethyl.....gal.		4.75 - 5.50
Alcohol, methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		41 - 42
Alcohol, denatured, 190 proof.....gal.		43 - 44
Alum, ammonia, lump.....lb.	0.31 - 0.31	0.4 - 0.4
Alum, potash, lump.....lb.	0.31 - 0.4	0.4 - 0.4
Alum, chrome lump.....lb.	0.71 - 0.8	0.8 - 0.8
Aluminum sulphate, commercial.....lb.	0.11 - 0.2	0.21 - 0.2
Aluminum sulphate, iron free.....lb.	0.21 - 0.21	0.3 - 0.3
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	0.71 - 0.7	0.8 - 0.8
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30 - 30	31 - 33
Ammonium carbonate, powder.....lb.	0.7 - 0.7	0.8 - 0.9
Ammonium chloride, granular (white sal ammoniac).....lb.	0.61 - 0.61	0.7 - 0.7
Ammonium chloride, granular (gray sal ammoniac).....lb.	0.61 - 0.7	0.71 - 0.7
Ammonium nitrate.....lb.	0.7 - 0.7	0.71 - 0.8
Amylacetate tech.....gal.		2.00 - 2.40
Arsenic oxide, (white arsenic) powdered lb.	0.7 - 0.7	0.71 - 0.8
Arsenic, sulphide, powdered (red arsenic) lb.	12 - 12	12 - 13
Barium chloride.....ton	50.00 - 51.00	52.00 - 60.00
Barium dioxide (peroxide).....lb.	21 - 21	22 - 23
Barium nitrate.....lb.	0.61 - 0.7	0.71 - 0.8
Barium sulphate (precip.) (blanc fixe) lb.	0.31 - 0.4	0.41 - 0.4
Blanc fixe, dry.....lb.	0.4 - 0.4	
Blanc fixe, pulp.....ton	45.00 - 55.00	
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Bromine.....lb.	20 - 21	21 - 26
Calcium acetate.....100 lbs.	1.75 - 2.00	
Calcium carbide.....lb.	0.41 - 0.4	0.5 - 0.5
Calcium chloride, fused, lump.....ton	23.00 - 24.00	24.50 - 28.00
Calcium chloride, granulated.....lb.	0.11 - 0.2	0.21 - 0.2
Calcium hypochlorite (bleach'g powder) 100 lb.	2.25 - 2.40	2.50 - 3.25
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		15 - 16
Camphor.....lb.		90 - 95
Carbon bisulphide.....lb.	0.6 - 0.6	0.61 - 0.7
Carbon tetrachloride, drums.....lb.	101 - 101	11 - 12
Carbonyl chloride, (phosgene).....lb.		60 - 75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.	0.31 - 0.4	
Chalk, precip., domestic, light.....lb.	0.31 - 0.31	
Chalk, precip., domestic, heavy.....lb.	0.31 - 0.31	
Chalk, precip., imported, light.....lb.	0.4 - 0.4	
Chlorine, gas, liquid-cylinders (100 lb.) lb.	0.6 - 0.6	0.61 - 0.7
Chloroform.....lb.		38 - 40
Cobalt oxide.....lb.		2.00 - 2.10
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	20 - 20	21 - 21
Copper cyanide.....lb.		58 - 60
Copper sulphate, crystals.....100 lb.	5.60 - 5.65	5.70 - 6.25
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....gal.		58 - 65
Ethyl acetate com. 85%.....gal.		
Ethyl acetate, pure (acetic ether, 90% to 100%).....gal.		93 - 111
Formaldehyde, 40 per cent.....lb.	101 - 101	
Fullers earth, f.o.b. mines.....net ton	16.00 - 17.00	
Fullers earth-imported powdered-net ton	30.00 - 32.00	
Fusel oil, ref.....gal.		2.50 - 3.00
Fusel oil, crude.....gal.		1.50 - 1.75
Glauber's salt (see sodium sulphate).....lb.		
Glycerine, c. p. drums extra.....lb.		161 - 17
Iodin ² , resublimed.....lb.		3.00 - 3.90
Iron oxide, red.....lb.		12 - 18
Iron sulphate (copperas).....ton	15.00 - 16.00	17.00 - 20.00
Lead acetate.....lb.		101 - 12
Lead arsenate, powd.....lb.	15 - 15	151 - 16
Lead nitrate.....lb.		15 - 20
Litharge.....lb.	0.71 - 0.71	0.8 - 0.8
Magnesium carbonate, technical.....lb.	0.6 - 0.6	0.61 - 0.8
Magnesium sulphate, U. S. F.....100 lb.	2.65 - 2.70	2.75 - 3.00
Magnesium sulphate, technical.....100 lb.		1.05 - 1.80
Methanol, 95%.....gal.		61 - 62

	Carlots	Less Carlots
Methanol, 97%..... gal.	\$ 45 - 46	\$0 63 - \$0 64
Nickel salt, double..... lb.	11 - 12	11 - 12
Nickel salt, single..... lb.	45 - 46	47 - 50
Phosgene (see carbonyl chloride)..... lb.	10 - 10 1/2	10 1/2 - 11
Phosphorus, red..... lb.	10 - 10 1/2	10 1/2 - 11
Phosphorus, yellow..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium bichromate..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium bitartrate (cream of tartar)..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium bromide, granular..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium carbonate, U. S. P..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium carbonate, 80-85%..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium chlorate, crystals..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium cyanide..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium hydroxide (caustic potash)..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium iodide..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium nitrate..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium permanganate..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium prussiate, red..... lb.	10 - 10 1/2	10 1/2 - 11
Potassium prussiate, yellow..... lb.	10 - 10 1/2	10 1/2 - 11
Rochelle salts (see sodium potas. tartrate)..... lb.	10 - 10 1/2	10 1/2 - 11
Salammoniac (see ammonium chloride)..... lb.	10 - 10 1/2	10 1/2 - 11
Sal soda (see sodium carbonate)..... lb.	10 - 10 1/2	10 1/2 - 11
Salt cake (bulk)..... ton	17.00 - 20.00	2.05 - 2.40
Soda ash, light..... 100 lb.	1.75 - 2.00	2.15 - 2.40
Soda ash, dense..... 100 lb.	2.05 - 2.10	2.15 - 2.40
Sodium acetate..... lb.	0.04 - 0.04 1/2	0.04 - 0.05
Sodium bicarbonate..... 100 lb.	2.25 - 2.30	2.35 - 2.75
Sodium bichromate..... lb.	0.07 - 0.07 1/2	0.08 - 0.08 1/2
Sodium bisulphate (nitre cake)..... ton	4.75 - 5.00	5.25 - 6.00
Sodium bisulphate powdered, U. S. P..... lb.	0.04 - 0.04 1/2	0.05 - 0.05 1/2
Sodium borate (borax)..... lb.	0.05 - 0.06	0.06 - 0.07
Sodium carbonate (sal soda)..... 100 lb.	1.70 - 1.80	1.85 - 2.10
Sodium chloride..... lb.	0.06 - 0.06 1/2	0.07 - 0.07 1/2
Sodium chloride..... long ton	12.00 - 13.00	26 - 27
Sodium cyanide..... lb.	0.26 - 0.26 1/2	0.26 - 0.27
Sodium fluoride..... lb.	1.00 - 1.10	1.10 - 1.12
Sodium hydroxide (caustic soda)..... 100 lb.	3.70 - 3.75	3.90 - 4.20
Sodium hyposulphite..... lb.	0.03 - 0.03 1/2	0.03 - 0.03 1/2
Sodium nitrite..... lb.	0.06 - 0.06 1/2	0.07 - 0.07 1/2
Sodium peroxide, powdered..... lb.	0.25 - 0.26	0.27 - 0.30
Sodium phosphate, dibasic..... lb.	0.04 - 0.04 1/2	0.04 - 0.05 1/2
Sodium potassium tartrate (Rochelle salts)..... lb.	0.17 - 0.17 1/2	0.17 - 0.18
Sodium prussiate, yellow..... lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (40 deg.)..... 100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium silicate, solution (60 deg.)..... 100 lb.	1.25 - 1.30	1.35 - 2.00
Sodium sulphate, crystals (Glauber's salt) 100 lb.	0.04 - 0.04 1/2	0.04 - 0.05
Sodium sulphate, fused, 60-62 per cent (conc.) lb.	0.03 - 0.03 1/2	0.03 - 0.04 1/2
Sodium sulphite, crystals..... lb.	0.10 - 0.11	0.11 - 0.15
Strontium nitrate, powdered..... lb.	0.05 - 0.05 1/2	0.05 - 0.06
Sulphur chloride, red..... ton	18.00 - 20.00	0.09 - 0.10
Sulphur, crude..... lb.	0.08 - 0.08 1/2	0.09 - 0.10
Sulphur dioxide, liquid, cylinders extra..... 100 lb.	2.25 - 3.10	2.00 - 2.75
Sulphur (sublimed), flour..... 100 lb.	2.00 - 2.75	2.00 - 2.75
Sulphur, roll (brimstone)..... 100 lb.	2.00 - 2.75	2.00 - 2.75
Talc—imported..... ton	30.00 - 40.00	0.09 - 0.09 1/2
Talc—domestic powdered..... ton	18.00 - 25.00	0.09 - 0.09 1/2
Tin bichloride..... lb.	0.08 - 0.08 1/2	0.09 - 0.09 1/2
Tin oxide..... lb.	0.09 - 0.09 1/2	0.09 - 0.10
Zinc carbonate..... lb.	0.14 - 0.14 1/2	0.15 - 0.16
Zinc chloride, gran..... lb.	0.09 - 0.09 1/2	0.09 - 0.10
Zinc cyanide..... lb.	0.42 - 0.44	0.45 - 0.47
Zinc dust..... lb.	0.11 - 0.11 1/2	0.11 - 0.12 1/2
Zinc oxide, XX..... lb.	0.07 - 0.07 1/2	0.08 - 0.09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.00 - \$1.05
Alpha-naphthol, refined..... lb.	1.15 - 1.20
Alpha-naphthylamine..... lb.	28 - 30
Aniline oil, drums extra..... lb.	17 - 18
Aniline salts..... lb.	25 - 26
Anthracene, 80% n drums (100 lb.)..... lb.	75 - 1.00
Benzaldehyde U. S. P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	85 - 95
Benzidine sulphate..... lb.	75 - 85
Benzoic acid, U. S. P..... lb.	60 - 65
Benzoate of soda, U. S. P..... lb.	52 - 55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	29 - 35
Benzene, 90%, in drums (100 gal.)..... gal.	27 - 32
Benzyl chloride, 95-97%, refined..... lb.	27 - 29
Benzyl chloride, tech..... lb.	20 - 23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	30 - 32
Beta-naphthol, tech..... lb.	30 - 32
Beta-naphthylamine, sublimed..... lb.	1.50 - 1.60
Cresol, U. S. P., in drums (100 lb.)..... lb.	16 - 17
Ortho-cresol, in drums (100 lb.)..... lb.	24 - 26
Creosote, 92-99%, straw color, in drums..... gal.	65 - 70
Creosote, 95-97%, dark, in drums..... gal.	60 - 65
Creosote, 50%, first quality, drums..... gal.	45 - 50
Dichlorobenzene..... lb.	0.06 - 0.09
Diethylaniline..... lb.	90 - 1.05
Dimethylaniline..... lb.	40 - 45
Dinitrobenzene..... lb.	21 - 25
Dinitrochlorobenzene..... lb.	25 - 27
Dinitronaphthalene..... lb.	32 - 35
Dinitrophenol..... lb.	38 - 40
Dinitrotoluene..... lb.	25 - 30
Dip oil, 25%, car lots, in drums..... gal.	31 - 35
Diphenylamine..... lb.	60 - 70
Hi-acid..... lb.	95 - 1.05
Meta-phenylenediamine..... lb.	1.05 - 1.10
Monochlorobenzene..... lb.	10 - 12
Monothylaniline..... lb.	1.30 - 1.40
Naphthalene crushed, in bbls..... lb.	0.07 - 0.08
Naphthalene, flake..... lb.	0.07 - 0.08
Naphthalene, balls..... lb.	0.08 - 0.09
Naphthionic acid, crude..... lb.	65 - 70
Nitrobenzene..... lb.	10 - 12
Nitro-naphthalene..... lb.	30 - 35
Nitro-toluene..... lb.	15 - 17 1/2
Ortho-amidophenol..... lb.	2.85 - 2.90
Ortho-dichlorobenzene..... lb.	15 - 20
Ortho-nitro-phenol..... lb.	75 - 80
Ortho-nitro-toluene..... lb.	15 - 20

Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.25 - 1.30
Para-amidophenol, HCl..... lb.	1.45 - 1.50
Para-dichlorobenzene..... lb.	.17 - .18
Paranitroaniline..... lb.	.77 - .80
Para-nitrotoluene..... lb.	.70 - .75
Para-phenylenediamine..... lb.	1.60 - 1.65
Para-toluidine..... lb.	1.10 - 1.15
Phthalic anhydride..... lb.	.37 - .40
Phenol, U. S. P., drums..... lb.	.12 - .16
Pyridine..... gal.	1.75 - 2.75
Resorcinol, technical..... lb.	1.40 - 1.50
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.20 - .21
Salicylic acid, U. S. P..... lb.	.23 - .24
Salol..... lb.	.75 - .77
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.26 - .28
Tolidine..... lb.	1.20 - 1.30
Toluidine, mixed..... lb.	.32 - .38
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.30 - .35
Xylenes, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .50
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .35

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 - \$0.21
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.34 - .38
Candelilla wax..... lb.	.23 - .24
Carnauba, No. 1..... lb.	.45 - .46
Carnauba, No. 2, North Country..... lb.	.22 - .22 1/2
Carnauba, No. 3, North Country..... lb.	.13 - .14
Japan..... lb.	.19 - .20
Montan, crude..... lb.	.04 - .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 - .05 1/2
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p..... lb.	.03 - .03 1/2
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04 1/2
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .05 1/2
Stearic acid, single pressed..... lb.	.09 - .09 1/2
Stearic acid, double pressed..... lb.	.09 - .09 1/2
Stearic acid, triple pressed..... lb.	.10 - .10 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.25 - 5.30
Rosin E-I..... 280 lb.	5.35 - 5.40
Rosin K-N..... 280 lb.	6.00 - 6.70
Rosin W. G.-W. W..... 280 lb.	7.00 - 7.25
Wood rosin, bbl..... 280 lb.	6.25 - 6.50
Spirits of turpentine..... gal.	.91 - .92
Wood turpentine, steam dist..... gal.	.89 - .90
Wood turpentine, dest. dist..... gal.	.88 - .89
Pine tar pitch, bbl..... 200 lb.	6.00 - 6.10
Tar, kiln burned, bbl (500 lb.)..... bbl.	10.00 - 10.10
Retort tar, bbl..... 500 lb.	9.00 - 9.10
Rosin oil, first run..... gal.	.36 - .37
Rosin oil, second run..... gal.	.39 - .40
Rosin oil, third run..... gal.	.46 - .47
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 - 1.95
Pine oil, pure, dest. dist..... gal.	1.50 - 1.55
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .47
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .36
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .76
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.35 - .36
Turpentine, crude, sp.gr. 0.900-0.970..... gal.	1.25 - 1.30
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 - .36
Pinewood creosote, ref..... gal.	.52 - .53

Fertilizers

Ammonium sulphate, bulk and double bags..... 100 lb.	\$2.30 - 2.60
Blood, dried, f.o.b. N. Y..... unit	4.00 - 4.10
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.37 - 2.40
Tankage, high grade, f.o.b. Chicago..... unit	2.75 - 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%..... ton	5.50 - 7.00
Tennessee, 76-80%..... ton	8.50 - 9.00
Potassium muriate, 80%..... ton	34.00 - 35.00
Potassium sulphate..... unit	1.00 - 1.10

Crude Rubber

Para-Upriver fine..... lb.	\$0.23 - .23 1/2
Upriver coarse..... lb.	.13 - .14
Upriver caucho ball..... lb.	.13 - .14
Plantation—First latex crepe..... lb.	.18 - .19
Ribbed smoked sheets..... lb.	.18 - .19
Brown crepe, thin, clean..... lb.	.15 - .16
Amber crepe No. 1..... lb.	.17 - .18

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.10	—	\$0.10
Castor oil, AA, in bbls.	lb.	.11	—	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13	—	.13
Coconut oil, Ceylon grade, in bbls.	lb.	.09	—	.09
Coconut oil, Ceylon grade, in bbls.	lb.	.10	—	.10
Corn oil, crude, in bbls.	lb.	.08	—	.08
Cottonseed oil, crude (f. o. b. mill)	lb.	.07	—	.07
Cottonseed oil, summer yellow	lb.	.09	—	.09
Cottonseed oil, winter yellow	lb.	.09	—	.10
Linseed oil, raw, ear lots (domestic)	gal.	.70	—	.71
Linseed oil, raw, tank cars (domestic)	gal.	.65	—	.66
Linseed oil, in 5-bbl lots (domestic)	gal.	.73	—	.74
Olive oil, denatured	gal.	\$1.13	—	\$1.20
Palm, Lagos	lb.	.08	—	.08
Palm, Niger	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07	—	.07
Peanut oil, refined, in bbls.	lb.	.10	—	.11
Rapeseed oil, refined in bbls.	gal.	.82	—	.83
Rapeseed oil, blown, in bbls.	gal.	.87	—	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08	—	.08
Soya bean oil, tank cars, f.o.b. Pacific coast	lb.	.07	—	.07

FISH

Light pressed menhaden	gal.	\$0.46	—	....
Yellow bleached menhaden	gal.	.48	—	....
White bleached menhaden	gal.	.50	—	....
Blown menhaden	gal.	.57	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$23.00	—	23.50
Barytes, ground, off color, f.o.b. Kings Creek	net ton	15.00	—	17.00
Barytes, crude, 88% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	6.00	—	7.00
Casein	lb.	.15	—	.16
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	20.00
Graphite, Ceylon lump, first quality	lb.	.05	—	.06
Graphite, Ceylon chip	lb.	.04	—	.05
Graphite, high grade amorphous crude	lb.	.00	—	.02
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	60.00
Kieselguhr, f.o.b. N. Y.	per ton	55.00	—	60.00
Magnesite, calcined	per ton	50.00	—	65.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	.70
Shellac, orange superfine	lb.	.71	—	.72
Shellac, A. C. garnet	lb.	.58	—	.60
Shellac, T. N.	lb.	.65	—	.66
Soapstone	ton	12.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in.	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points	net ton	52-55	—	....
Chrome cement, 40-50% Cr ₂ O ₃	net ton	30-32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , anaks, in car lots, f.o.b. Eastern shipping points	net ton	33-35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30-35	—	....
Magnesite brick, 9-in. straight	net ton	65-76	—	....
Magnesite brick, 9-in. arches, wedges and keys	net ton	77	—	....
Magnesite brick, scraps and splits	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40-42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42-45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35-38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$225.00
Ferrocromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11	—	....
Ferrocromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12	—	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00	—	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00	—	58.35
Spiegelisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	54.00	—	55.00
Ferrosilicon, 75%	gross ton	115.00	—	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00	—	....
Ferrovandium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	21.00	—	22.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	21.00	—	22.00
Coke, foundry, f.o.b. ovens	net ton	3.50	—	3.75
Coke, furnace, f.o.b. ovens	net ton	2.75	—	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00	—	....
Fluorspar, standard, domestic washed gravel	net ton	20.00	—	22.00
Kentucky and Illinois mines	lb.	.01	—	.01
Ilmenite, 52% TiO ₂ , per lb. ore	unit	.24	—	....
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	net ton	55.00	—	60.00
Manganese ore, chemical (MnO ₂)	lb.	.48	—	.50
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	unit	27.00	—	....
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, fines, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.11	—	.12
Rutile, 95% TiO ₂ , per lb. ore	lb.	.12	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	2.50	—	2.75
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	35.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.25
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375-4.40
Zinc, spot, New York	5.15-5.175
Zinc, spot, E. St. Louis	4.70-4.725

OTHER METALS

Silver (commercial)	oz.	\$0.66
Cadmium	lb.	1.00-1.10
Bismuth (500 lb. lots)	lb.	1.85@1.95
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	93.00-105.00
Iridium	oz.	170.00@200.00
Palladium	oz.	60.00-65.00
Mercury	75 lb.	50.00-51.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	28.75
Copper rods	19.75
High brass wire	17.45
High brass rods	14.75
Low brass wire	18.75
Low brass rods	19.25
Brass tubing	25.50
Brass bronze tubing	30.50
Seamless copper tubing	21.25
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	9.75@10.25
Copper, heavy and wire	9.25@9.50
Copper, light and bottoms	7.50@8.00
Lead, heavy	3.50@3.75
Lead, tea	3.00@3.25
Brass, heavy	4.25@4.50
Brass, light	3.25@3.50
No. 1 yellow brass turnings	4.00@4.25
Zinc	2.00@2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	\$2.63	\$2.78	\$2.78
Soft steel bars	2.53	2.68	2.68
Soft steel bar shapes	2.53	2.68	2.68
Soft steel bands	3.13	3.28	3.28
Plates, 1/2 to 1 in. thick	2.63	2.78	2.78

*Add 15¢ per 100 lb. for trucking to Jersey City and 10¢ for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The Southern Pacific Railroad Co., 65 Market St., San Francisco, has completed plans for the construction of a new crossotting plant at Wilmington, Los Angeles Harbor, to consist of five 1-story buildings, estimated to cost about \$150,000 with equipment. The erection contract has been let and work will be placed under way at once.

BURBANK—The American Aluminum Products Co., Los Angeles, care of Richard D. King, 519 Van Nuys Bldg., architect, has taken bids for the erection of its proposed new plant at Burbank, to consist of a group of 7 buildings, estimated to cost in excess of \$75,000.

Connecticut

NEW LONDON—The Robert Gair Co., 45 Washington St., Brooklyn, manufacturer of paper boxes, containers, etc., is considering the erection of a new plant in Connecticut, on site in the vicinity of its New London works. The company has arranged for a mortgage of \$5,000,000 on its properties, to provide for increased working capital and expansion, including the proposed new mill.

NEW HAVEN—Fire in the 4-story factory at 138-44 State St., occupied by a number of industrial concerns, destroyed a portion of the works of the Elm Novelty Mfg. Co., manufacturer of paper boxes, with a loss estimated at about \$20,000; C. H. Pulk, paper goods, with loss of about \$15,000, and the plant of the Central Brass Co., with loss of about \$8,000.

Florida

MOORE HAVEN—The City Council is planning for the installation of a new filtration plant at the municipal waterworks.

Georgia

CAMILLA—Fire recently destroyed a portion of the plant of the Camilla Cotton Oil & Fertilizer Co., with loss estimated at about \$20,000.

Iowa

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., will break ground about March 15 for the erection of its proposed new cement plant at Dubuque, consisting of a number of mill buildings, estimated to cost about \$1,500,000. The C. L. Pillsbury Co., 1200 Second Ave., South Minneapolis, Minn., is engineer.

Maryland

BALTIMORE—The American Concrete Tile & Products Co., 305 Gaither Bldg., recently organized with a capital of \$250,000, has preliminary plans under way for the erection of a new plant on local site, estimated to cost about \$70,000, including machinery. The company will specialize in the manufacture of brick, tile, blocks and kindred products. John E. Springer is president, and John W. Ritter, secretary and treasurer.

BALTIMORE—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has filed plans for the construction of a new steel gas holder at its gas-manufacturing plant, 278 ft. in diameter, and 225 ft. high, to cost \$360,000. The Bartlett-Hayward Co., Scott and McHenry Sts., has the erection contract.

BALTIMORE—In connection with the enlargement of its oil refinery in the Canton district, now under way, the Standard Oil Co., Pratt and Commerce Sts., purposes to make this plant the second largest works of its kind in the country, with capacity for handling about 55,000 bbl. of crude oil per day, the larger amount of which will be from the Mexican fields of the company. Extensive storage facilities will be provided.

Massachusetts

SPRINGFIELD—The Strathmore Paper Co. has awarded a contract to the Casper Ranger Construction Co., Holyoke, Mass., for the construction of an addition to its plant.

WALTHAM—The Elastoid Fiber Co., Norman and Marshall Sts., is arranging for the early occupancy of its new 1-story plant addition, 72 x 180 ft., now in course of erection, to include a 1-story power house. All miscellaneous contracts have been let. The plant will cost about \$35,000.

ASHLAND—Fire, Jan. 10, destroyed a portion of the plant of the Angier Mills, Main St., manufacturers of waterproof papers, with loss estimated at about \$200,000. The plant consisted of three main buildings.

MALDEN—Wadsworth, Howland & Co., Inc., 139 Federal St., Boston, manufacturer of paints, etc., has awarded a contract to Coleman Bros., Charlestown, Mass., for the construction of a 4-story addition, 40 x 80 ft., to its plant on Green St., Malden, estimated to cost about \$27,000.

Michigan

CLAWSON—The Clawson Brick & Tile Co. has acquired a local site for the construction of a new plant, to be equipped for the manufacture of brick, tile and other burned clay products.

CADILLAC—Construction has been inaugurated on a new 1-story and basement foundry, 87 x 100 ft. on local site, to be owned and occupied by a new company now being organized by R. J. Teetor of the Mitchell Digging Iron Co., Cadillac. It will be equipped for the manufacture of iron, steel and other metal castings, and is estimated to cost in excess of \$100,000. Frank D. Chase, Inc., 646 North Michigan Ave., Chicago, Ill., is architect and engineer.

Missouri

CAPE GIRARDEAU—The Cape Girardeau Portland Cement Co. is planning for extensions and improvements in its plant, including the remodeling of certain portions of the works and the installation of new grinding and other machinery. It is proposed to develop an output of about 2,400 bbl. per day. New equipment will be installed at the power plant. The work is estimated to cost about \$150,000. Charles L. Harrison is president.

ST. LOUIS—The Obeur-Nester Glass Co., 25 North 2nd St., is considering preliminary plans for the construction of a 1-story addition to its glass manufacturing plant at Broadway and Belt Sts., East St. Louis, Ill., estimated to cost approximately \$75,000.

MONETT—The Hammond Dehydration Co. has plans under way for the construction of a new 2-story dehydration plant on local site. Hickenlively & Marks, Landers Bldg., Springfield, Mo., are architects.

New Jersey

CROSSWICKS—The General Rendering Co., a subsidiary of Wilson & Co., U. S. Stock Yards, Chicago, Ill., will make a number of alterations and improvements at its local plant, and has temporarily discontinued operations for this purpose. The machinery will be modernized and capacity increased. Wylie E. Brown is manager.

PERTH AMBOY—The Raritan Copper Works, foot of Elm St., a subsidiary of the Anaconda Copper Co., 25 Broadway, New York, is perfecting plans for the manufacture of copper shingles and affiliated products at its plant, and machinery for this purpose will be installed at an early date. It is planned to manufacture, also, copper leaders, gutters, etc.

New York

LONG ISLAND CITY—The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., manufacturer of sanitary ware, has acquired the plant of the Goodyear Tire & Rubber Co., Jackson Ave. and Honeywell St., Long Island City, for an eastern works. It consists of a 6-story building, aggregating about 63,000 sq. ft. of floor space, and was secured for a consid-

eration said to be \$500,000. Operations will be inaugurated at an early date.

Oklahoma

OKMULGEE—The Highway Oil Refining Co. is completing plans for the rebuilding of its local gasoline plant, recently destroyed by fire with loss estimated at about \$25,000. W. E. Burke is secretary and manager.

TULSA—The Brite-Lite Polish Co., 411 Robinson Bldg., recently organized, has plans in preparation for the construction of a new local plant, 50 x 75 ft., for the manufacture of polishes. Machinery will be installed for an initial capacity of about 500 bottles per day. S. S. Bassett is vice-president, and P. G. Hefflinger, secretary and treasurer.

Ohio

TOLEDO—The Electric Glass Co., 505 St. Clair St., has awarded a contract to Otto C. Hoelzer, 706 West Central St., for the erection of a new 2-story plant at 1310 Front St., to be used for the manufacture of glass specialties. Henry Pinggen is president and treasurer.

Pennsylvania

PHILADELPHIA—The Boice Folding Box Co., Inc., a new organization, manufacturer of paper folding boxes and containers, is completing plans for the construction of a new plant at Ogden and Hutton Sts. E. L. Rothschild, 1420 Chestnut St., is architect. Wilson Scott Boice, 4020 Spruce St., is president of the company.

POTTSTOWN—The Vulcaweld Rubber Co., manufacturer of automobile tires and other rubber products, is having plans prepared for the construction of a new 2-story plant, 60 x 260 ft., on site recently acquired on West High St. A 1-story power house, 40 x 65 ft., will be erected, also. The plant is estimated to cost about \$200,000. E. W. Smith heads the company.

PITTSBURGH—The Thermatomic Carbon Co., a new organization, headed by R. H. Uhlinger, 3612 Bates St., is arranging for the erection of a new plant on site selected in Louisiana, for the manufacture of carbon black and affiliated products. A permit has been granted by the Louisiana State Department of Conservation for the new works.

Tennessee

CHATTANOOGA—The Signal Mountain Portland Cement Co., James Bldg., will break ground early in March for the construction of its proposed new plant in the vicinity of Chattanooga. The mill will consist of a number of buildings, and is estimated to cost in excess of \$500,000. J. L. Senior is president.

KNOXVILLE—The Knoxville Cement Products Co., manufacturer of cement bricks, tile, blocks and kindred products, is planning for the installation of additional machinery at its plant. The company was organized recently under state laws. C. P. Koehn is president and manager.

CHATTANOOGA—The Ocoee Copper Co., 1135 Volunteer Life Bldg., will take bids early in February for the construction of its proposed new flotation plant at Ducktown, near Chattanooga, on site recently acquired. It will be completely equipped for the treating of copper ores, and is estimated to cost about \$200,000. J. I. Carter is president, and L. P. Hope, engineer in charge.

Washington

VANCOUVER—The Pacific States Rubber Co., recently organized by A. M. Elliott, Vancouver, and associates, is arranging for the purchase of a local site for the construction of a large plant for the manufacture of rubber products of various kinds. The initial plant unit will cost about \$500,000, and later extensions will bring the investment up to more than \$1,000,000. Plans for the plant will be prepared at an early date.

West Virginia

NITRO—The Seydel Mfg. Co., 86 Forrest St., Jersey City, N. J., manufacturer of chemical products, is arranging for the establishment of a large plant on site recently acquired at Nitro, and for which purpose a company of similar name has lately been organized with capital of \$1,500,000, effecting a merger between the Seydel company and the Nitro Products Co., manufacturer of like specialties. Operations will be concentrated at the new location and the present plant removed to this point. Herman Seydel heads the company.

New Companies

THE TEXALO OIL CORP., Buffalo, N. Y., has been incorporated with a capital of \$300,000, to manufacture oil products. The incorporators are B. Rumsey, J. Argue and B. F. Milsom. The company is represented by Abbott & Abbott, Iroquois Bldg., Buffalo.

THE PHILADELPHIA PORCELAIN CO., Woodlynne, N. J., has been incorporated with a capital of \$50,000, to manufacture porcelain ware of various kinds. The incorporators are William T. Allen, William A. Leiser and John Tuthill, Woodlynne.

THE ANDERSON MAGNESIA PRODUCTS CO., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture magnesias and asbestos goods. James G. Anderson, 47 Harvard St., is president and treasurer; John G. Anderson is secretary.

THE DAWSON BRICK CO., Dawson Springs, Ky., has been incorporated with a capital of \$20,000, to manufacture brick and other burned clay products. The incorporators are Lee O. Dixon, Charles F. Cato and I. N. Day, all of Dawson Springs.

THE NATIONAL PRODUCTS CO., 3058 West Harrison St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical by-products. The incorporators are Max Schwartz and Harry Robbins.

THE CARBON FIREBRICK & COAL CO., Carbon, Ind., has been incorporated with a capital of \$25,000, to manufacture firebrick and other refractory products. The incorporators are J. L. Sydenstricker; E. L. Strader and Benjamin Simpson, all of Carbon.

THE PHOENIX RUBBER CO., Brockton, Mass., has been incorporated with a capital of \$25,000, to manufacture and deal in rubber goods. Charles D. Wener is president; and Charles D. Burnes, 100 Columbia St., Brookline, Mass., treasurer.

THE THOMPSON CHEMICAL CO., New York, N. Y., has been incorporated with a capital of \$1,000,000 under Delaware laws, to manufacture chemicals and chemical by-products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE MERVYN LABORATORIES, Brooklyn, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals and chemical byproducts. The incorporators are S. W. Green, S. Richardson and B. Rafkin. The company is represented by Bertrand Ettinger, 50 Court St., Brooklyn.

THE MARYLAND STEEL CORP., 4th and C Sts., Baltimore, Md., has been incorporated with a capital of \$100,000, to manufacture steel, nickel, copper and other metal products. The incorporators are Irving Reynolds, Louis H. Reuter and A. Arthur Jenkins.

THE IMPERIAL POLISH CO., Philadelphia, Pa., has been incorporated with a capital of \$10,000, to manufacture polishes and kindred specialties. Henry C. Watt, 618 North 43rd St., Philadelphia, is treasurer.

THE CARBON DIOXIDE PLANT FOOD CO., St. Augustine, Fla., has been incorporated with a capital of \$4,500, to manufacture fertilizer specialties. W. B. Guy is president; Robert Ranson, vice-president and R. D. Crawley, St. Augustine, secretary and treasurer.

THE UNITED RUBBER CORP., Portland, Me., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture rubber products of various kinds. Edgar J. Warren is president and treasurer. Doris I. Laffin, Portland, is representative for the company.

THE DRY COLOR CORP., Wilmington, Del., has been incorporated under state laws with capital of \$2,050,000 to manufacture colors, chemical products, etc. The company is represented by the United States Corporation Co., Dover, Del.

THE CREAM CITY MIRROR PLATE CO., Milwaukee, Wis., has been incorporated with a capital of \$50,000, to manufacture mirrors, glass products, etc. The company will succeed the company of the same name, with local plant, recently dissolved. The incorporators are H. R. Seidel, Edward H. Smith and William Mauthe. The company is represented by Bloodgood, Kemper & Bloodgood, Mitchell Bldg., Milwaukee.

THE MERIDIAN FIBRE CO., Meridian, Miss., has been incorporated with a capital of \$35,000, to manufacture fiber products. The incorporators are A. J. Lyon, R. L. Tinsley and Stanton Brown, all of Meridian.

THE R. W. SHEETS PAPER BOX CO., 1008 Mulberry St., Rockford, Ill., has been incorporated with a capital of \$100,000, to manufacture paper boxes and kindred prod-

ucts. The incorporators are R. M. Anderson, R. W. and C. A. Sheets.

THE MATE CORP. OF AMERICA, Huntington, L. I., N. Y., has been incorporated with a capital of \$350,000, to manufacture chemicals, drugs and affiliated products. The incorporators are T. J. Doran, F. P. J. Crowley and H. Quick. The company is represented by John Boyle, Jr., 570 East 161st St., New York.

THE AMERICAN RADIUM APPLIANCE CO., Morristown, N. J., has been incorporated with a capital of \$100,000, to manufacture radium specialties. The incorporators are Ernest B. Rubsamen, Samuel C. Cutler and Francis H. Glazebrook, 171 South St., Morristown.

THE WALLINGFORD STEEL CO., Wallingford, Conn., has been incorporated with a capital of \$200,000, to manufacture steel and other metal products. The incorporators are C. W. Leavenworth, F. A. Wallace and E. B. Cleborne, all of Wallingford.

THE DESOTO OIL AND GAS CO., Jacksonville, Fla., has been incorporated with a capital of \$100,000, to manufacture petroleum products. J. H. Johnson, Orange, Tex., is president and manager; P. V. Summers, Jacksonville, vice-president; and Herschel Ehler, Houston, Tex., secretary and treasurer.

THE MEAKER SPARK PLUG CO., Detroit, Mich., has been incorporated with a capital of \$10,000, to manufacture porcelain spark plugs. The incorporators are Ralph H. Meaker, Edward F. Loud and Harry L. Pierson, Jr., 7939 Lafayette Ave., Detroit.

THE STERLO DRUG & CHEMICAL CO., Richmond, S. I., N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are W. P. and P. F. Tiernan, and J. S. Minogue, Jr. The company is represented by J. H. Tiernan, Cedar Grove Beach, Dongan Hills, S. I.

THE PALMETTO OIL CO., Tulsa, Okla., has been incorporated with a capital of \$50,000, to manufacture petroleum products. The incorporators are Stanley D. Campbell, Ray S. Fellows and Albert H. Bell, all of Tulsa.

THE NORTH RIVER BRICK CO., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture bricks. The incorporators are F. Demovitch, M. M. Sherower and F. Raab. The company is represented by Joseph, Demov & Feinstein, 277 Broadway, New York.

THE HOLLAND TILE & GRAVEL CO., Holland, Mich., has been incorporated with a capital of \$25,000, to manufacture burned clay drain tile, sewer pipe and cement products. The incorporators are George J. Huntley, W. E. Dunn and H. E. Dunn, all of Holland.

THE MODERN CHEMICAL CO., Wilmington, Del., has been incorporated with a capital of \$100,000, under state laws, to manufacture chemicals and chemical byproducts. The incorporators are William B. Clark and Mark R. Yates, Washington, D. C. The company is represented by Charles G. Guyer, 826 Market St., Wilmington.

THE SWITZER-PARKE CO., Houston, Tex., has been incorporated with a capital of \$30,000, to manufacture baked enamels, drying paints, etc. The incorporators are Homer E. and S. J. Switzer, Melville B. and W. M. Parke, all of Houston.

THE JOHN H. WALSH CO., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture leather specialties, bookbinders' paste and other kindred products. The incorporators are John H. and F. G. Walsh, and W. A. Smith. The company is represented by Guggenheimer, Curtin, Coyle & Glynn, 233 Broadway, New York.

THE MOCKLAIR CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture fiber products. The incorporators are H. A. Mocklair, H. May and G. E. McArdle. The company is represented by Butcher, Tanner & Foster, 1 Madison Ave., New York.

THE CHEMICAL INK CO., Brooklyn, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are J. A. Selas, K. Dyer and W. H. Stieglitz. The company is represented by M. J. Moore, 141 Broadway.

THE DUMONT FERTILIZER CO., INC., Wilmington, Del., has been incorporated with a capital of \$500,000, to manufacture fertilizer products. The company is represented by the Corporation Service Co., Wilmington.

THE ENAMEL PRODUCTS CO., INC., Indianapolis, Ind., has been incorporated with a capital of \$15,000, to manufacture vitreous enamel products. The incorporators are L. B. Mosiman, B. C. Street and R. C. Street, Indianapolis.

Capital Increases, Etc.

THE SHAFFER OIL & REFINING CO., Oklahoma City, Okla., manufacturer of refined oil products, with office at 208 South La Salle St., Chicago, Ill., has arranged for a bond issue of \$1,500,000, for general financing, operations, etc.

THE JOHNSTON CHEMICAL CO., Shepherd, Mich., has filed notice of dissolution under state laws.

THE NEW YORK QUEBRACHO EXTRACT CO., 50 Maiden Lane, New York, N. Y., has filed notice of change of name to the Tannin Corp.

THE CORONA CHEMICAL CO., 16 East 40th St., New York, N. Y., has filed notice of increase in capital from \$25,000 to \$500,000.

THE KING PHILIP OIL CO., New Bedford, Mass., has filed notice of increase in capital from \$3,000,000 to \$6,000,000.

THE SOUTH PORTO RICO SUGAR CO., 62 Cedar St., New York, N. Y., has disposed of a bond issue of \$6,000,000, for financing, general operations, etc. F. A. Dillingham is president.

THE MESABI IRON CO., 25 Broad St., New York, N. Y., has arranged for an increase in capital from \$33,000,000 to \$53,000,000.

THE CALUMET OIL CO., El Paso, Tex., has filed notice of increase in capital from \$50,000 to \$150,000.

THE WILLIAM E. DEE CO., 30 North La Salle St., Chicago, Ill., manufacturer of firebrick, tile, sewer pipe and other burned clay products, has filed notice of increase in capital of \$750,000 to \$2,000,000, to cover the merger of a number of subsidiary companies.

THE WAUGH CHEMICAL CORP., 2 Rector St., New York, N. Y., has filed schedules in bankruptcy with liabilities stated as \$211,276, and assets, \$182,994.

Percival Wilds and Walter S. Wyman, both of Augusta, Me., have been appointed receivers for the KENNEBEC PAPER CO. and the CUSHNOC PAPER CO., both of that city, under bond of \$25,000 in each instance.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

NORTHWEST MINING ASSOCIATION will hold a convention in the Chamber of Commerce Bldg., Spokane, Wash., Feb. 14 to 18.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.